The New Stereo Phonograph Cartridges

SEPTEMBER 1958

Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

Five European Hi-Fi Amplifiers

■

You Can Watch Transatlantic TV

■

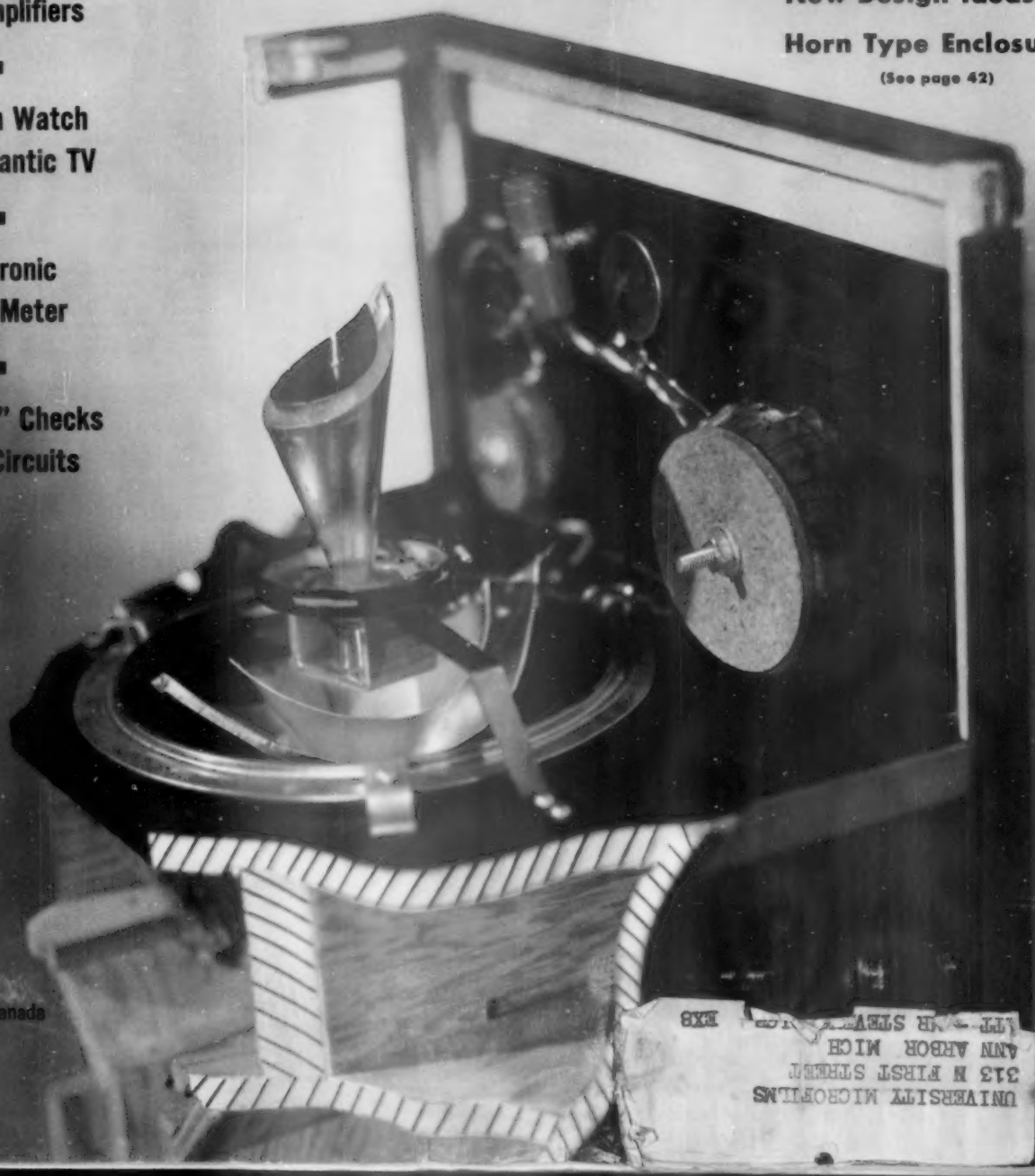
Electronic Wind Meter

■

"Subber" Checks Sync Circuits

New Design Ideas in Horn Type Enclosure

(See page 42)



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For all your hi-fi listening... **Jensen** presents these new Stereo Director* Systems with challenging performance . . . in high fashion furniture . . . at prices that set new standards for loudspeaker values.

JENSEN DS-100 DUAL 3-WAY SYSTEM WITH THE NEW

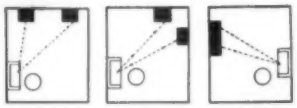
Jensen STEREO DIRECTOR*

The DS-100 dual stereo unit, in the popular lowboy, is the answer to the buyer's demand for a complete stereo reproducer in one cabinet. This handsomely styled loudspeaker system provides two completely independent 3-way speaker systems with 12" Flexair woofers (total of 6 speakers) which can be used together for superior spread source monophonic sound, as well as stereo. The two Stereo Directors, each having an 8 inch mid-channel and compression driver h-f unit, allow flexibility in cabinet placement with maximum effectiveness in aiming the sound to the favored listening area. Crossover frequencies 600 and 4000 cycles. 32" H., 52" W., 18¼" D. Available in Walnut, Tawny Ash and Mahogany

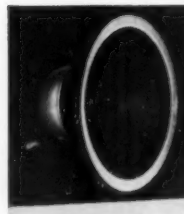
Net Price.....369.50

HOW THE NEW JENSEN STEREO DIRECTOR WORKS . . .

A pair of these Director assemblies are used in the DS-100 Dual 3-way System (illustrated above), a single assembly in the SS-100, mounted inside on the shelf above the Flexair woofer enclosure. Chassis easily rotated without moving cabinet, has an 8" m-f unit, compression-driver tweeter, network and control. All frequencies above 600 cycles are reproduced by the Stereo Director assembly. Complete system is also available in kit form.



Jensen STEREO DIRECTOR lets you place the speakers wherever decor dictates, square to the wall for best appearance. You send the sound to you, instantly adjust for best stereo listening without moving cabinet.



ABOUT JENSEN'S NEW FLEXAIR WOOFER

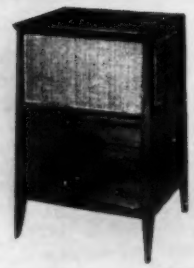
The new Jensen Flexair Woofers are designed to extend bass response down to very low frequencies. They have highly-damped superlow resonance at the very bottom of the audio range—16 to 20 cycles. They have an exceptional degree of linearity and are capable of a total movement of 1". In even a relatively small Bass-Superflex enclosure, they deliver their extreme low-frequency performance with a new low in distortion.

JENSEN SS-100 3-WAY SYSTEM WITH THE NEW

Jensen STEREO DIRECTOR

Equivalent in performance to one section of the DS-100 Dual Stereo system, this elegant model includes Stereo Director Chassis and 12" Flexair woofer in the Jensen Bass-Superflex enclosure for smooth coverage of the range from 20 to 15,000 cycles. Adequately driven to normal room levels with a 10 watt amplifier. Two SS-100's are ideal for stereo in the difficult-to-arrange living room, assuring perfect sound in the favored listening area. 32" H., 21" W., 18¼" D. Available in Walnut, Tawny Ash and Mahogany.

Net Price.....179.95



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Use these new kits for superb sound... finest stereo performance.

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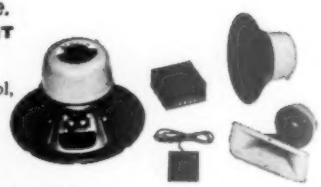
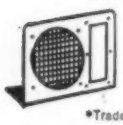
KT-33 BASIC 3-WAY SYSTEM KIT

Includes Flexair 12-inch woofer, special 8 inch m-f unit, and RP-103 compression h-f unit. Complete with control, crossover network, wiring cable, and full instructions. Impedance 16 ohms; power rating 30 watts.





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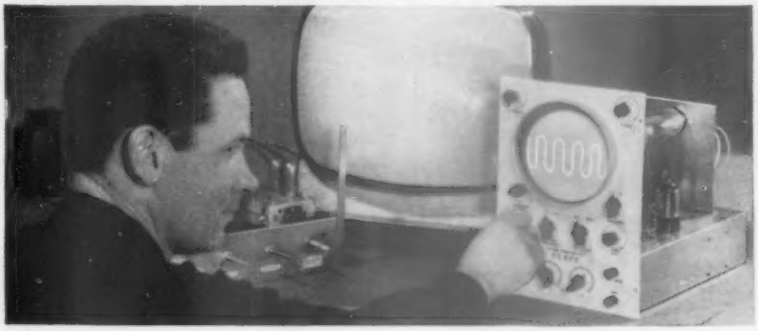

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ON THE COVER

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The speakers and part of a special cutaway enclosure reveal some intimate construction details of the Eico HFS-2 speaker system.

Color original by Habershaw Studios, New York, N. Y.

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News Briefs

STEREO PHONO EQUIPMENT and "ready-for-stereo" units have become available in an extensive profusion of combinations and permutations. All phonograph manufacturers have taken note of stereo in their 1959 models and the buyer of so-called "packaged hi fi" has a choice of stereo sets ranging in price from $59.50 to $2,500. If he is interested in a phonograph but does not want to invest in stereo immediately, manufacturers assure him that all their new-model monophonic phonographs are easily converted to stereo.

In this monophonic-but-ready-for-stereo field, the buyer has these choices:

1. Standard sets that can be converted with a kit containing stereo cartridge and leads plus adding another amplifier and speaker system.

2. Sets with monophonic cartridge but with four leads in the pickup arm, so that a stereo cartridge and an additional plug-in amplifier and speaker can be connected easily.

3. Sets with stereo pickups and one amplifier. These can be made into stereo phonographs by adding another amplifier and speaker.

4. Sets with stereo pickups and dual-channel amplifiers, requiring only an extra speaker to make them complete stereo rigs.

Most manufacturers offer two or more of these choices; at least one offers all four, plus complete stereo outfits.

The complete stereo phonographs are available in single, two- and three-cabinet models. The single cabinets are usually of lowboy design, with speakers mounted at opposite ends. Some of the three-cabinet models have three separate speaker systems (the center unit combining both channels to fill the "hole in the middle" sometimes noted).

ELECTRONIC COOLER–WARMER for baby's bottle, less than half a cubic foot in size, has been demonstrated by Westinghouse Electric Corporation, which outlined a whole new range of compact household appliances which both heat and cool, at the National Housewares Manufacturers Association show at Atlantic City, N. J.

The cooling–heating appliances are based on the effect discovered by Peltier in 1834—that passing electricity through junctions of two dissimilar materials creates heating or cooling, depending on the current's direction. RCA's widely known research in electronic refrigeration and air conditioning is founded on the same principle.

The bottle cooler–warmer contains 50 junctions mounted geometrically around an aluminum container. Vertical aluminum fins dissipate removed heat. It keeps the bottle cool at 40° or heats it to 100° and was shown in 110-volt ac and automobile models.

Westinghouse said its electronic refrigerating–heating equipment occupies about 10% less space than would comparable compression refrigeration gear, requires "at least 50% less apparatus" and is free of noise and vibration. Still in the developmental stage, company officials predicted that thermoelectric cooling would replace conventional refrigeration techniques in the "not too far future."

Also demonstrated was a mobile hostess cart with separate compartments to keep food warm or cool, operated from both a rechargeable battery and line current. Other possible household products using the same principle which were itemized (but not demonstrated) by vice president Chris J. Witting: heating and cooling pads or blankets, refrigerated mixing bowls, electric Thermos bottles, cooling coasters, combination freezer–cookers.

"SANDWICH" MAGNETIC TAPE, introduced for computer and instrumentation use, has magnetic material on the inside of the tape where it doesn't contact the recording head. The secret is a plastic layer, 50 micro-inches thick, covering the oxide coating. The manufacturer, Minnesota Mining & Manufacturing Co., claims it outwears conventional instrumentation tapes by 10 times or more and prolongs recording- and playback-head life because it doesn't deposit oxide on them.

The thin tape layer between the coating and the head reduces the signal level approximately 6 db at 1-mil wavelength. Medium- and long-wavelength responses are essentially unaffected.

MICROWAVE AMPLIFIER which can be packed into a space of 4 cubic inches and offers the possibility of far more efficient performance of radar equipment in aircraft and missiles, has been developed by RCA Laboratories.

Classified as a basic improvement in the solid-state device known as a para-

(*Continued on page* 10)

In Spare Time at Home—Prepare for a Better Job—or Your Own Business in One of the Many Branches of

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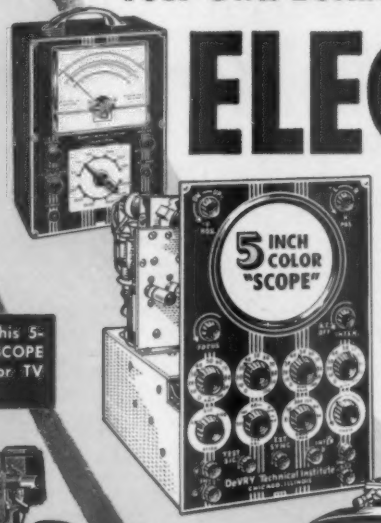

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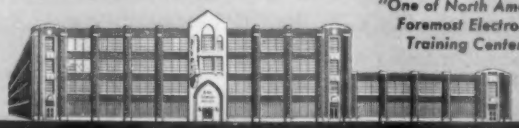

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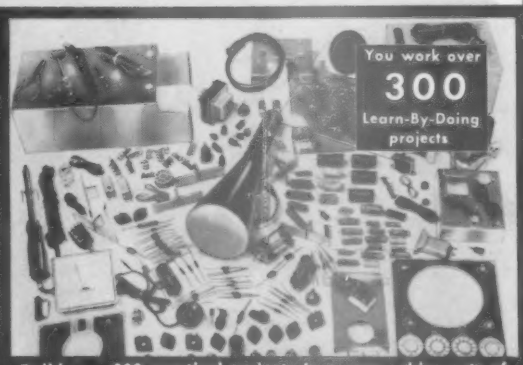

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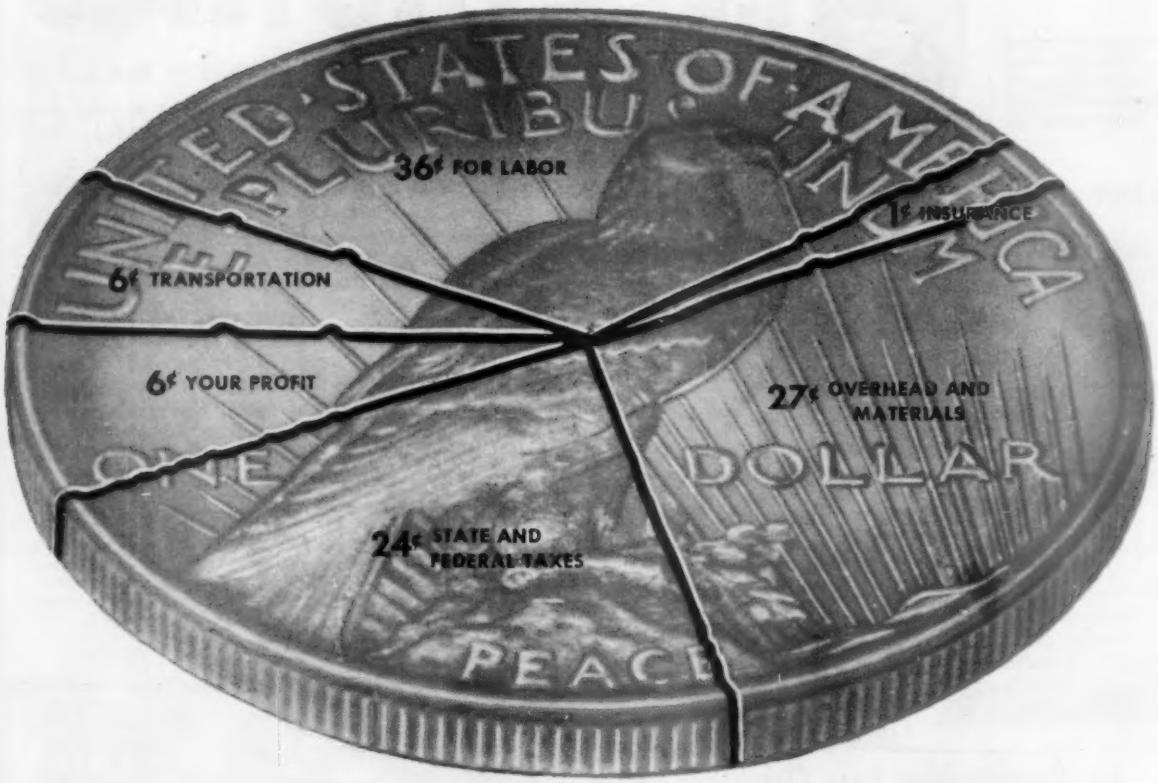

Let your customers know how much they get and how little you make on an average service call. Show them this chart. It was compiled by an independent organization for Raytheon and is based on research of Independent TV-Radio Service Dealer costs from coast to coast. It might be a good idea if you studied it carefully to see if any phase of your business is costing more than it should.

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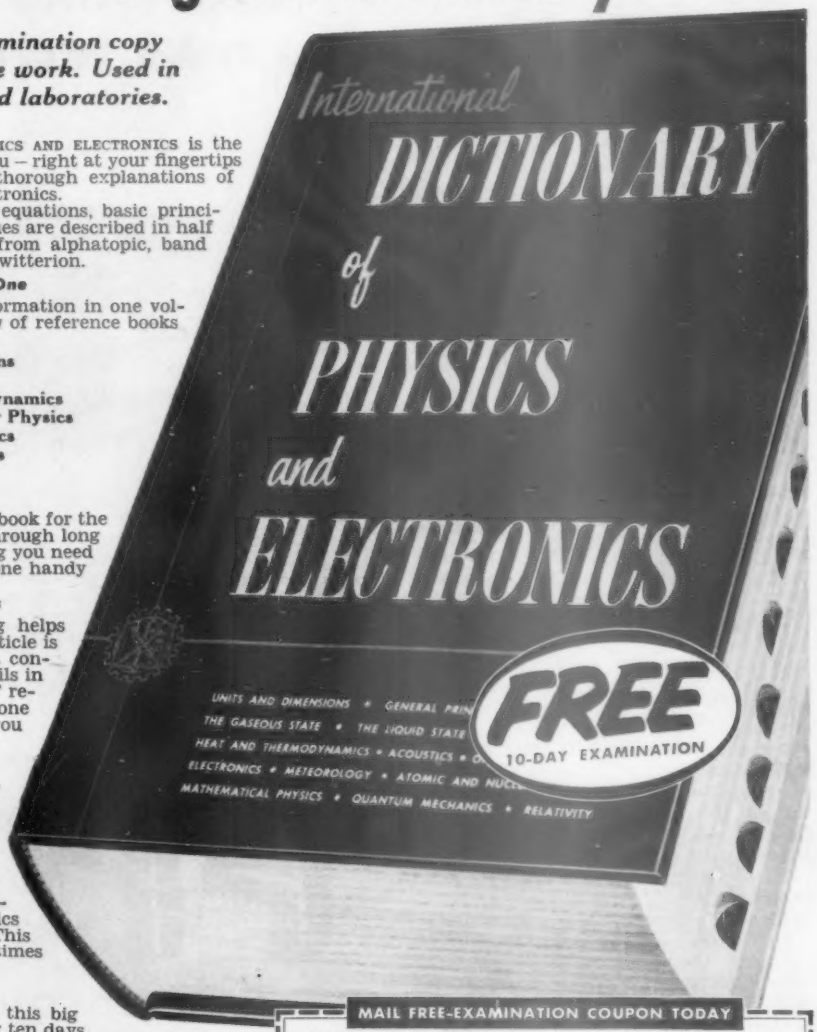

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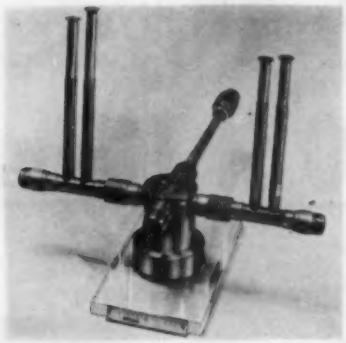

metric microwave amplifier, it uses a germanium diode to detect an incoming high-frequency signal and either a transistor or a pencil type tube oscillating at a low frequency to provide a "pumping" action that amplifies the signal. Parametric amplifiers have been developed in the past, but the pumping frequency was always at least twice that of the signal. According to RCA, the new technique places the parametric amplifier principle "in an entirely new light."

The new development holds particular promise at the higher end of the microwave band—even to frequencies above 10,000 mc. It requires a power supply of only a fraction of a watt, and its size permits extreme miniaturization.

FOUR UHF TV STATIONS left the air since our last report:

KSAN-TV, San Francisco, Calif.....32
WITV, Fort Lauderdale-Miami, Fla. 17
WFLB-TV, Fayetteville, N. C. 18
WKAR-TV, East Lansing, Mich. 60

No new stations went on the air during the period, reducing the total now broadcasting to 538 (447 vhf and 91 uhf). Of these 30 are noncommercial. WKAR-TV, a noncommercial station owned by Michigan State University, was the second educational TV station to leave the air.

Another uhf station is due to go off the air Oct. 1. It is WBUF, Buffalo, Channel 17, owned by the National Broadcasting Co.

There has been one change in call letters:

WLBZ-TV, Bangor, Me. 2
(formerly WTWO)

Though the number of television stations diminished over the 30-day period, radio stations are at an all-time high. A recent survey shows 3,253 AM broadcast stations on the air at midyear, an increase of 42 since the first of the year and almost 3 times as many as there were at the end of World War II. There are 548 FM outlets on the air, up 8 during the year, but still well below FM's all-time high of 706.

NEW USES FOR FM broadcast band are being sought by the Federal Communications Commission, which has asked for proposals for "subsidiary services" which could be instituted without disturbing FM broadcasting. The FCC specifically mentioned use of the multi-

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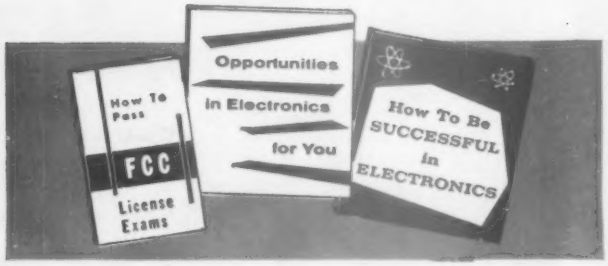

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plex technique to provide such special services as facsimile, stock market reports, slow-scan video transmission of advertisements, price quotations for supermarkets, paging service, traffic light control and stereophonic broadcasting, on a free or subscription basis.

One unusual application of multiplexing is already in operation. Station KDKA-FM, Pittsburgh, has been using a multiplex subchannel to feed Pittsburgh Pirates baseball games to 20 radio stations in the surrounding area. The station continues to broadcast its regular classical music programs on its main carrier channel. The multiplex channel programs can't be received without special equipment. Although multiplexing of subscription background music service by FM stations has been authorized for nearly 3 years, the Pittsburgh authorization was the first official sanction of non-musical multiplexing on a regular basis.

Calendar of Events

Hi-Fi Music Show, Sept. 5–7, DeWitt Clinton Hotel, Albany, N. Y.
Keystone Electronic Service Conference and Exhibition, Sept. 10–13, Carnegie Hall, Pittsburgh, Pa.
Instrument-Automation Conference and Exhibit, Sept. 15–19, Convention Hall, Philadelphia, Pa.
High Fidelity Show and Music Festival, Sept. 19–21, Palmer House, Chicago, Ill. (RADIO-ELECTRONICS and the Gernsback Library will exhibit in Room 746.)
Hi-Fi Music Show, Sept. 19–21, Onandaga Hotel, Syracuse, N. Y.
National Symposium of Telemetering, Sept. 22–24, Americana Hotel, Miami Beach, Fla.
Industrial Electronics Conference, Sept. 24–25, Rackham Memorial Bldg., Detroit, Mich.
Hi-Fi Music Show, Sept. 26–28, Sheraton Hotel, Rochester, N. Y.
High Fidelity Show, Sept. 30–Oct. 4, Trade Show Bldg., New York, N. Y. (RADIO-ELECTRONICS and the Gernsback Library will exhibit in Room 525.)
Symposium on Engineering Writing and Speech, Oct. 1–2, Biltmore Hotel, New York.
Conference on Radio Interference Reduction, Oct. 1–2, Armour Research Institute, Chicago, Ill.
Hi-Fi Music Show, Oct. 3–5, Multnomah Hotel, Portland, Ore.
Hi-Fi Music Show, Oct. 3–5, Hotel Statler, St. Louis, Mo.
American Industrial Electronics Exposition, Oct. 3–12, Planten un Blomen Exposition Park, Hamburg, Germany.
IRE Canadian Convention, Oct, 8–10, Exhibition Park, Toronto, Canada.
Hi-Fi Music Show, Oct. 10–12, Benjamin Franklin Hotel, Philadelphia, Pa.
Hi-Fi Music Show, Oct. 10–12, Sheraton-Gibson Hotel, Cincinnati, Ohio.
National Electronics Conference, Oct. 13–15, Hotel Sherman, Chicago.
Hi-Fi Music Show, Oct. 17–19, Hotel Statler, Detroit, Mich.
New England Hi-Fi Show, Oct. 17–19, Hotel Touraine, Boston, Mass.
Society of Motion Picture & Television Engineers Convention, Oct. 19–24, Sheraton-Cadillac Hotel, Detroit, Mich.
URSI Fall Meeting, Oct. 21–22, Penn State, Univ., University Park, Penna.
Hi-Fi Show, Oct. 23–26, Wisconsin Hotel, Milwaukee, Wis.
Radio-Fall Meeting, Oct. 27–28, Sheraton Hotel, Rochester, N. Y.
Hi-Fi Show, Oct. 29–Nov. 1, Windsor Hotel, Montreal, Canada.
Electron Devices Meeting, Oct. 30–Nov. 1, Shoreham Hotel, Washington, D. C.

END

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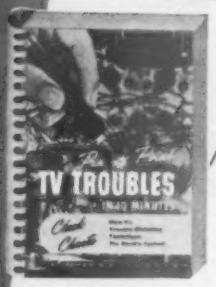

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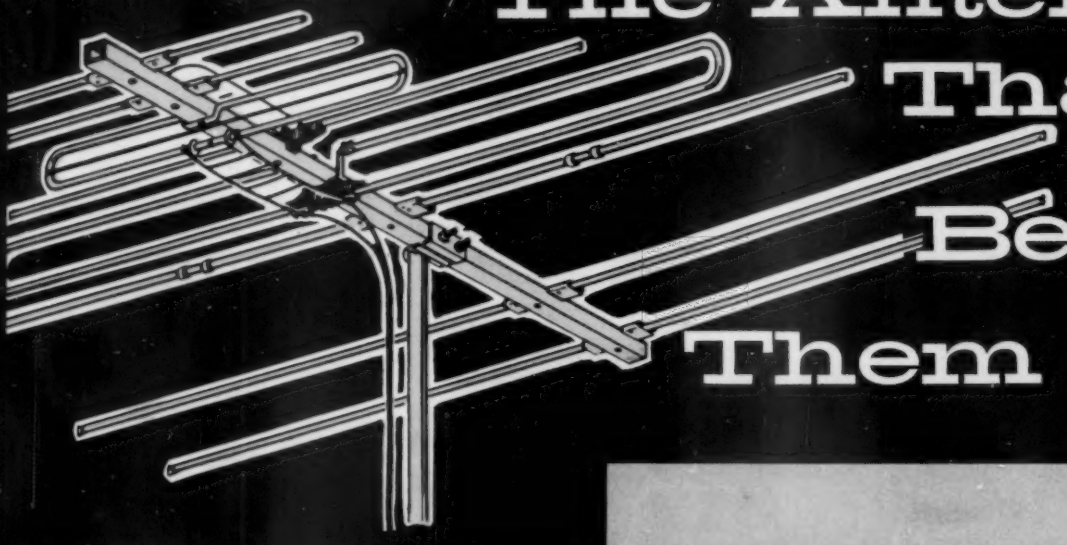

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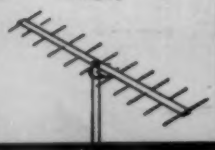

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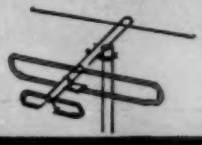

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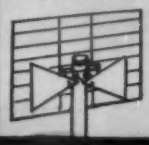

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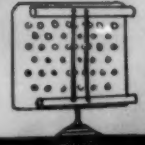

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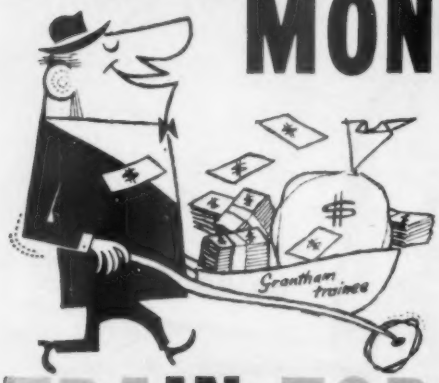

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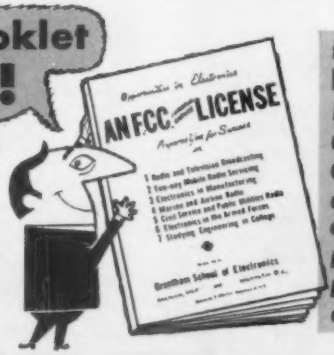

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Correspondence

ORIGINAL AC–DC CIRCUIT

Dear Editor:

I have recently had the opportunity of reading the interesting article "From Coherer to Spacistor" by T. R. Kennedy, Jr., which appeared in the Anniversary Issue of RADIO-ELECTRONICS [April, 1958]. I wish to congratulate Mr. Kennedy for writing such a comprehensive and complete article on the progress of electronics during the past 50 years.

Naturally, in preparing an article of such wide scope, there is always the possibility of omitting pertinent data. For this reason, I am writing to call your attention to the fact that in May, 1932, *Radio-Craft* published the first article ever to appear in print describing my original ac–dc circuit. I applied for the patent on this circuit on Feb. 12, 1932, and was awarded US Patent 2,086,256.

As mentioned in Mr. Kennedy's article, the first International Kadette ac–dc set containing the circuit of my invention did not appear in *Radio-Craft* until February, 1933, just 9 months later. Incidentally, the Kadette was *not* a three-way portable. This was a much later development, covered by my Patent 2,280,630.

Getting back to the ac–dc circuit, after a number of years of litigation, the validity of my patent was established and RCA, AT&T and other users of the ac–dc circuit became licensees of it.

Amagansett, N. Y. HARRY G. CISIN

GOLD IN THE STICKS

Dear Editor:

Fifteen years ago I moved from Chicago to Miami, Fla., to start a radio repair business. I was a big-city boy. I believed to get business, you had to go where business is—a big city.

I operated in Miami for about 6 years. I was moderately successful in getting my share of business. We opened at 8:00 am and closed at from 9–10:30 pm. Sure, we took Sundays off, in spite of the fact that many of our competitors did not. We were plutocrats.

I remember at that time my telephone ad ran about $25 a month. I drove as far as 20 miles on a service call—all stop-and-go city driving. When I put an ad in the local paper, it covered a city of 200,000 souls scattered all over Hell's Half-acre. The ad was so costly that I could not afford to turn down a customer no matter how far away he was.

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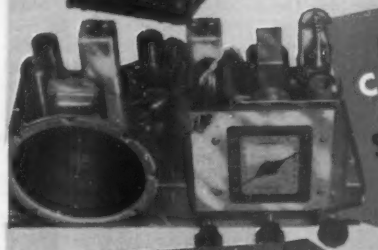

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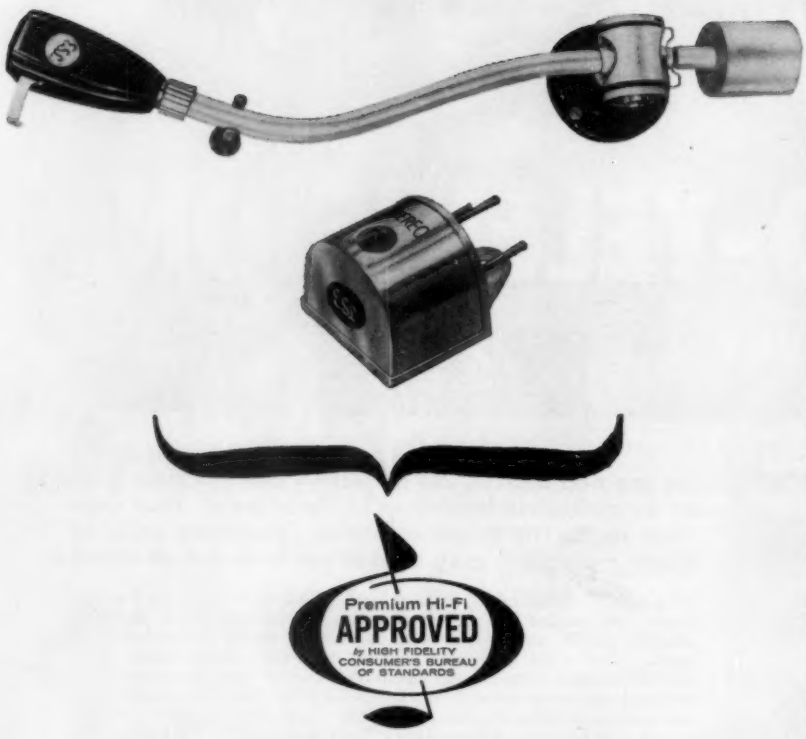

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The next problem—where to go and what to do? I had always dreamed of living on the Florida keys. School was just about out; so I suggested we move to the keys for the summer. My wife and kids were all for it; so we took a run down to look things over. I counted TV antennas from Homestead, which is at the north end of the keys, to the toll bridge. There were 59 antennas, just not enough to make a living on. Well, I wanted a vacation. I had a few dollars, and so I set up a shop on wheels in a large truck and I figured I would fix a set or two, maybe a few radios, and have a lot of time to fish and swim for 3 months. How wrong I was!

We moved into our apartment at 7:00 pm Saturday. At 8:00 am Sunday we started downstairs to go swimming. The Gulf of Mexico was in our backyard. On the way down a man hollered at me, "Are you the new TV man?" I assured him I was. He wanted service right then. I told him it was Sunday, and I was going swimming and I would fix him up the next day. He said, "Go on and swim—I'll wait for you," and he did. He sat on the dock until I got tired of seeing him, so I went to fix his set. I repaired seven sets that day in my bathing trunks, and never caught up on my work for the 3 months I was there.

I taught my landlord the TV service business during the 3 months and then sold him the business. It was one of the best 3 months we ever spent, financially and pleasure-wise.

I now avoid big cities and little cities, and look for the woods where everyone, myself included, is sure there is no business. It will amaze you — but, brother, it is there! Do a good job, and you can live an easy, pleasant and profitable life in the sticks, on an island or in the woods. Try it!

CARROLL S. SHAW
Fort Myers Beach, Fla.

SQUARE-WAVE GENERATOR

Dear Editor:

I note in the June RADIO-ELECTRONICS an article entitled "Square-Wave Generator" (page 92). Apart from some changes in the output circuit, this is virtually identical to the circuit I developed several years ago, which was published in the July, 1952, *Wireless World* (London) and later in *Radio Laboratory Handbook*. I would therefore like to comment on its operation and on the values of certain resistors in your article.

The circuit relies on the amplitude being kept small in order to maintain a balanced waveform. The plate square wave is differentiated by the grid time constant and the amplitude is such that *no grid current flows*. The grid waveform is therefore balanced about ground potential.

Amplitude is kept low by a low-value plate load and, as this also determines rise and fall time, this is desirable. In your article, you give this as 47K, whereas my value was 4.7K. [Incidentally, your diagram is wrong in that it

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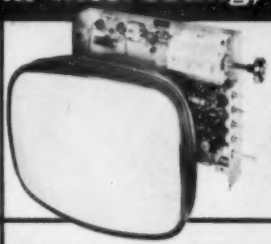

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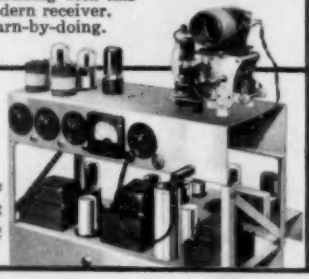

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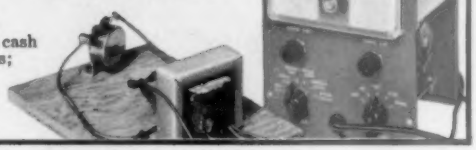

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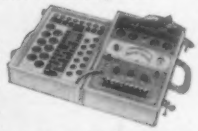

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CORRESPONDENCE *(Continued)*

shows R3 (47K) connected to the wrong side of C6 (0.1 uf).]

The grid resistor should always be much higher than the plate load, so that it never appreciably shunts the load resistor. If this is not so, the amplitude will vary at various frequency settings, and also the 50–50 balance may be upset. I used 39K as the fixed grid limit resistor, about eight times the plate load value. If your value of 3.9K is used, then there will be amplitude variation. As your quoted frequency ranges are approximately similar to mine, I would imagine it should have been 39K.

Use of a high value of amplitude control such as 500K is not advisable. At mid-settings its series resistance together with stray capacitance forms a low-pass filter which increases rise and fall times. This stray capacitance is lessened somewhat by cathode feedback in the output stage, but not sufficiently for consistent rise and fall times at different amplitude settings.

S. F. SINFIELD
Suton, Bedfordshire, England

TVI AND THE LAW

Dear Editor:

I have read several articles about correcting TV and radio interference and feel that it should be unnecessary for half a dozen hi-fi or TV owners to go through the expense of having the interference checked by some one and then the further expense of having to buy filters to correct it.

It seems to me that instead of six people putting out money, the owner of the defective or malfunctioning TV, etc., should have to correct it by law.

In this city there are a great number of companies using electronic sealing machinery; perhaps there are about 200 machines or more. The government required them to enclose all their machinery in screen rooms because of a radar installation less than a mile away. This I think illustrates the point:

The Government did not try to block the interference at the installation, but rather at the source—at the machine owners' expense. Therefore why shouldn't the owner of any machine creating *severe* TV or radio disturbance be made to spend his money correcting it, instead of making his neighbors pay for installing filters?

Newburg, N. Y. JOHN DAGION

FOR ANTIQUE COLLECTORS

Dear Editor:

I have a collection of old radios and phonographs, which includes about 20 radios of 1926–37 vintage and 10 phonographs from a 1913 Edison to a 1920 model. Most of the sets are not in operating condition because of minor troubles or missing parts.

I am interested in selling these for what I paid for them—50 cents to $5 apiece. In fact, some I would give away to a collector who is interested.

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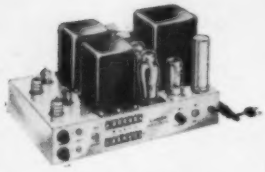

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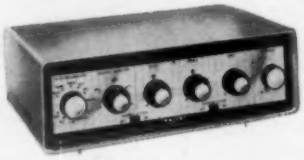

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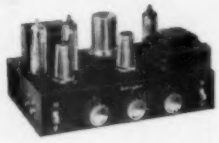

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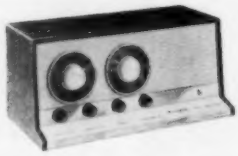

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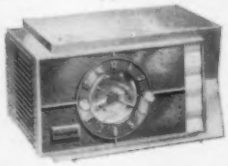

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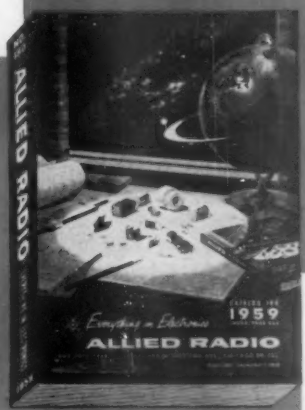

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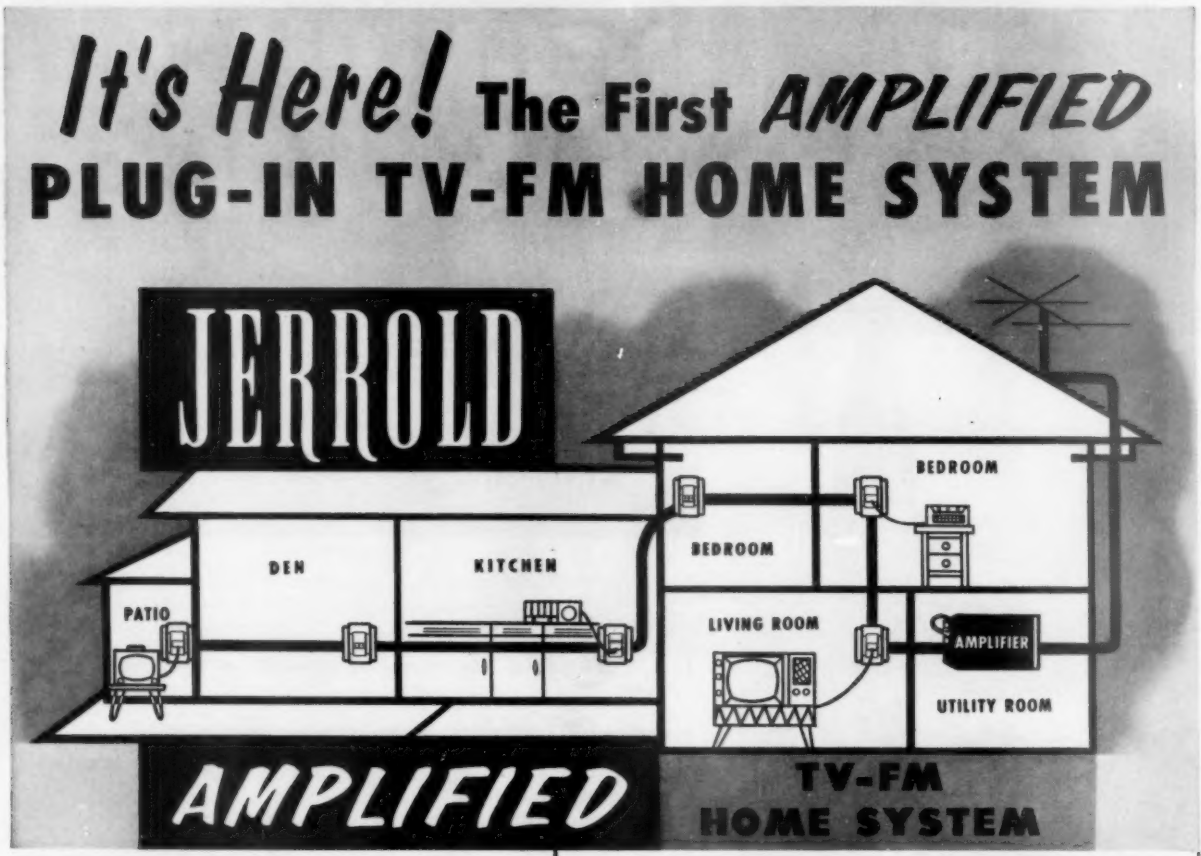

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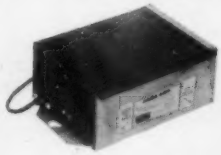

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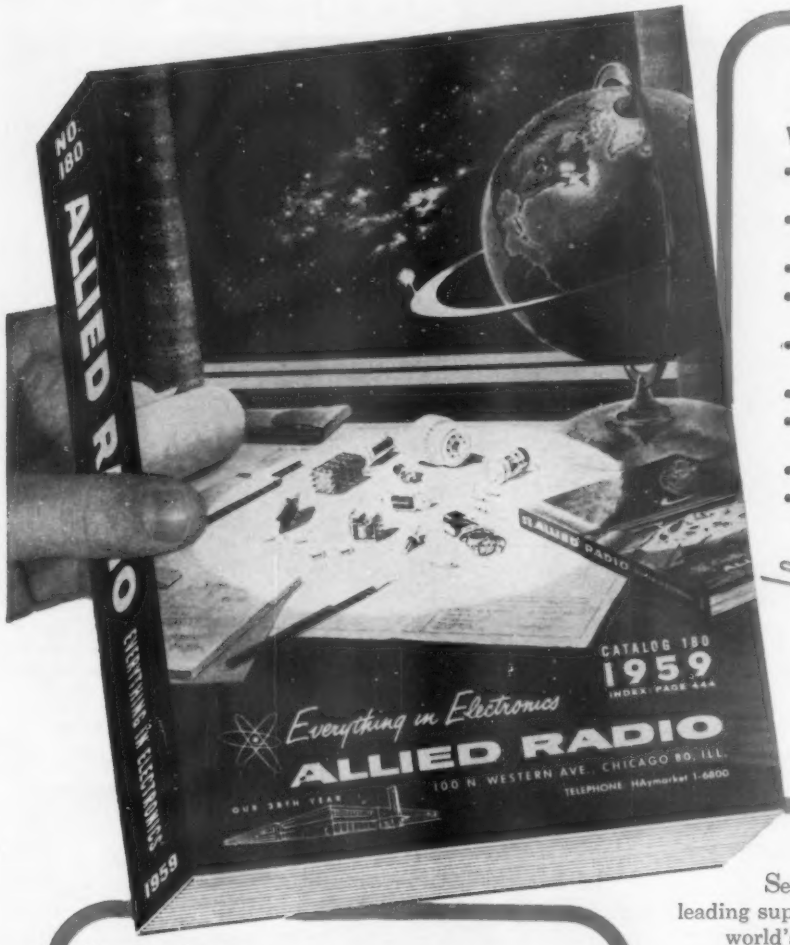

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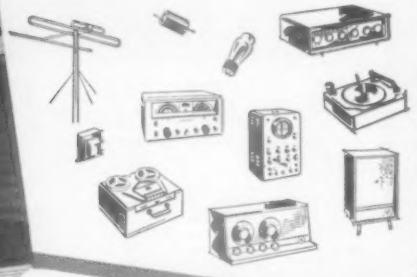

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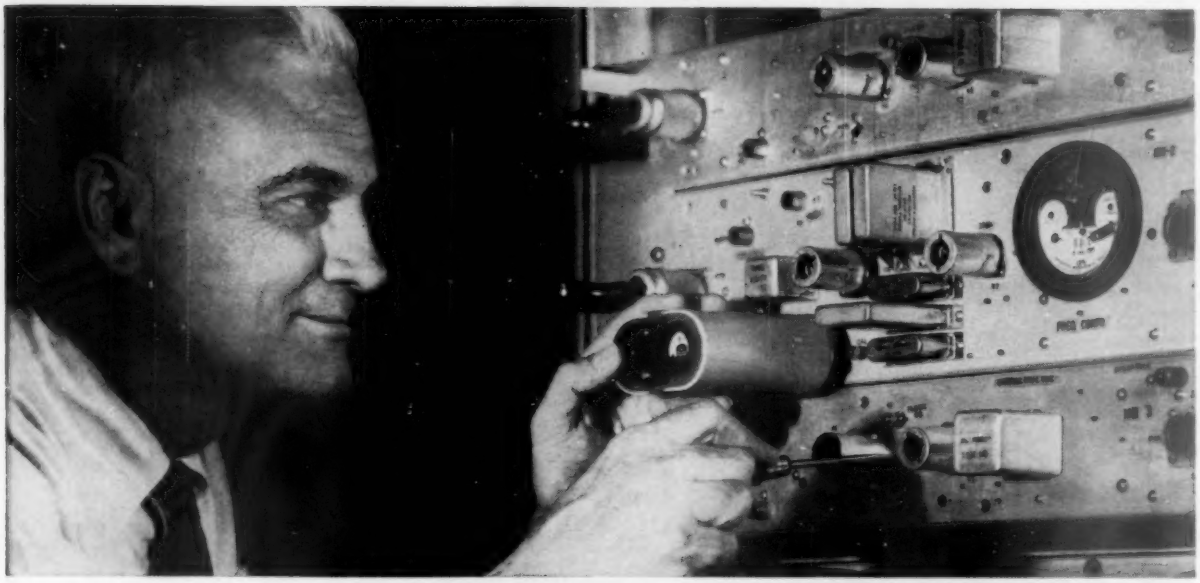
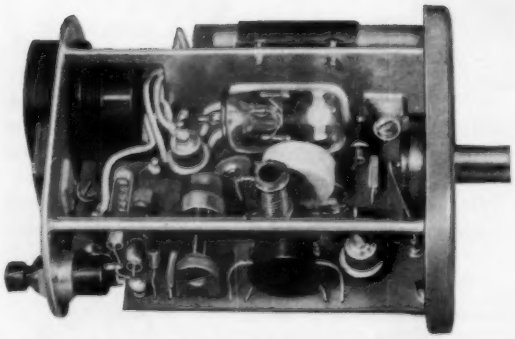
Bell Laboratories Announces Pocket-Sized Frequency Standard for Microwave Systems



Lawrence Koerner, who developed the portable frequency standard, demonstrates how the device can be plugged in at a radio relay station to supply a checking frequency. Battery-powered, the device maintains precision calibration for several months.



Inside the portable frequency standard. Four Laboratories-developed devices make it possible: (1) transistor, which converts the power from a battery to radio frequency oscillations; (2) voltage reference diode, which maintains constant voltage; (3) piezoelectric crystal unit of superlative stability; (4) thermistor, which corrects for temperature variations.

Microwave radio relay systems depend critically on the accuracy of their "carrier" frequencies. At scores of relay stations along a route, carrier frequency oscillators must be checked periodically against a signal from a precise standard.

In the past, the maintenance man has had to obtain his checking frequency by picking up a standard radio signal from a government station. This operation takes time—and requires elaborate equipment.

With a new *portable* frequency standard developed by Bell Laboratories engineers, the job is much simplified. To check an oscillator, the portable standard is plugged in, and a button is pressed. In seconds, it supplies a checking frequency accurate to one part in a million.

Until now, such precision in a frequency standard has been obtainable only in a laboratory. The new portable standard makes it available for routine use in the Bell System. First use of the standard will be to maintain frequency control in a new microwave system for telephone and TV, now under development at Bell Laboratories.

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MONAURAL PREAMPLIFIERS (stack 2 for Stereo)

HF65: superb new design. Inputs for tape head, microphone, mag-phono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. **HF65A** Kit **$29.95,** Wired **$44.95. HF65** (with power supply) Kit **$33.95.** Wired **$49.95.**

HF61: "Rivals the most expensive preamps" — Marshall, AUDIOCRAFT. **HF61A** Kit **$24.95,** Wired **$37.95, HF61** (with power supply) Kit **$29.95.** Wired **$44.95.**

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HF50: 50-Watt Ultra Linear Power Amplifier with extremely high quality Chicago Standard Output Transformer. Identical in every other respect to HF60, same specifications at 50 watts. Kit **$57.95.** Wired **$87.95.** Matching Cover E-2 $4.50.

HF35: 35-Watt Ultra-Linear Power Amplifier version of the HF60 above. Kit **$47.95.** Wired **$72.95.**

HF30: 30-Watt Power Amplifier employs 4-EL84 high power sensitivity output tubes in push-pull parallel, Williamson circuit, 20 db feedback, & high stability margin. 2-EZ81 full-wave rectifiers for highly reliable power supply. Unmatched value in medium-power amplifiers. Kit **$39.95.** Wired **$62.95.** Matching Cover E-3 $3.95.

HF22: 22-Watt Power Amplifier version of the HF60 above. Kit **$38.95.** Wired **$61.95.**

HF14: 14-Watt Power Amplifier of the HF81 above. Kit **$23.50.** Wired **$41.50.**

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HF52: 50-Watt Integrated Amplifier with complete "front end" facilities & Chicago Standard Output Transformer. Ultra-Linear power amplifier essentially identical to HF50. "Excellent value" — Hirsch-Houck Labs. Kit **$69.95.** Wired **$109.95.** Matching Cover E-1 $4.50.

HF32: 30-Watt Integrated Amplifier combines excellent HF30 power amplifier above with versatile preamplifier featuring tape head & microphone inputs, scratch & rumble filters, all amplifier facilities. Kit **$57.95.** Wired **$89.95.** Both include cover.

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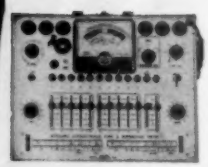

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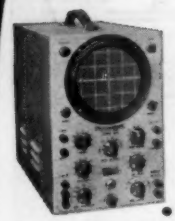

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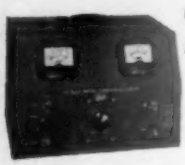

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IS MILITARY RADAR DOOMED?

. . . New Scientific Advances Change Our Concepts . . .

A driving rain falling on a smooth, hard sidewalk rebounds from the surface in various directions. The same rain falling on desert sand is completely absorbed. Light rays falling on most substances are reflected in various directions. The same light falling on two Tourmaline crystal plates—crossed at right angles to each other—is completely extinguished. Light is electromagnetic. So is radar. Hence, ever since the advent of radar, science has occupied itself with devising means to prevent radar's high-frequency waves from bouncing back.

During World War II, British and US Air Forces used a number of schemes to prevent the enemy from determining the actual position of their bombers, particularly at night and during overcast. Bombers dropped long thin aluminum strips which gave a multiplicity of readings on the enemy's radar indicators, thus confusing his gunners.

Later, special paints and coverings were tried on various aircrafts to "insulate" them against radar. Similar ideas were tried on exposed conning towers and periscopes of submarines. None of these measures were too successful at the time.

Warfare throughout history has taught that every new war implement, in due time, will have a "counter." The bow and arrow was countered by the protective shield. The fortress was countered by destructive gunfire. Rifles and their bullets in the field were minimized by slit trenches. Tanks were annihilated by cannon and bazookas. A and H Bombs can be destroyed in flight by other A and H Bombs, *if they can be intercepted early enough.* This is true whether they are delivered via aircraft or intercontinental ballistic missile (ICBM).

The latter, speeding at the rate of 15,000 miles per hour, does not give the defender much time to locate and destroy it high up before it strikes a city or other target. Hence, efficient radar to search out the missile quickly and accurately is a paramount requirement.

Yet, scientists on both sides of the Iron Curtain have long been engaged in devising means to nullify radar long-distance detection of planes and missiles. If this can be done effectively, then theoretically, neither side will have a defense. Theoretically, also, if there were a 100% radar "insulator," both nations would be "naked" against ICBM attacks, hence both would be checkmated. This would be a perfect standoff, and for a time there would be an enforced, if jittery, peace.

Recent advances seem to point in this direction. Thus, Wright Air Development Command scientists have been successful in perfecting an anti-radar "paint" that greatly reduces radar detection of aircraft and missiles. Note particularly the term *reduce*—so far as is known, no known paint or substance *completely* insulates a moving craft against radar reflection. Yet a Government spokesman, according to *Science News Service*, states: "There is every reason to believe the Russians are working on such paints and they just might even be ahead of us; . . . if they perfect anti-radar paints, what will happen to our Distant Early Warning system in Canada, and Texas Tower radar posts in the Atlantic?" He also hastened to add that existing and contemplated anti-radar paints even at their best could not completely hide a plane or missile from radar, but could only reduce the chances of discovery.

Anti-radar "paints" today, in reality, are extra heavy coatings. In their disfavor is a considerable weight. It is known that they are made of horsehair or equivalent plastics impregnated with carbon (carbon black or soot) or of special rubber material bonded to ceramics or brass. This prevents the radar waves from bouncing back, because the material is supposed to absorb the waves—i.e., the electromagnetic energy. In this respect, it acts much as the tourmaline plates, discussed at the beginning of this article, when struck by light.

The comparatively new art of anti-radar devices is as yet too young to expect perfect results. Nevertheless, progress in a "hot" field such as this is inexorable. One would dwell in a fool's paradise if one counted on the belief that a near 100% anti-radar system would never come about. Indeed, in our opinion, near-perfection must be expected to be realized in the foreseeable future.

As in all war innovations, even a perfected anti-radar means will, in time, be countered. An absolute standoff has never lasted long in history.

We must not forget, either, that perfect anti-radar would prove a serious nuisance in many respects. Camouflaged enemy aircraft masquerading as our own *could not be reported by radar when approaching and crossing our borders.* They could fly unmolested over our country on reconnaissance missions at will, photographing our defense plants, etc. Enemy submarines, too, could make similar missions along our shores, particularly at night—if we had no other detecting means.

For these, and other, reasons, anti-radar devices must, in time, be counteracted. What will be such a "counter?" One answer will no doubt be the present more or less secret infra-red instrumentality.

As we ascend higher into the radio-frequency band, past the millimeter waves, we emerge into the infra-red spectrum, the quasi-optical range which we have termed in the past *electronoptics.* By using infra-red (or near infra-red) frequencies in our future radar and other detecting devices, it is quite possible that present and later anti-radar systems will prove to be useless. It is already known that infra-red frequencies have a number of advantages over present-day radar. Other inventions no doubt will be made to counter anti-radar developments—the electromagnetic spectrum still holds many future surprises.

—*H. G.*

the HI-FI AMPLIFIER ABROAD

Five amplifiers and one preamp, all European types, show the low-power approach to high fidelity

By A. V. J. MARTIN

THE EL84/6BQ5, that remarkable audio output tube, has been in common use in Europe for some years and a number of hi-fi amplifiers have been designed around it. The four circuits described here are typical of careful, well proven designs. Similarly, the high-power high-performance EL34/6CA7 is now commonly available and may form the basis of quality amplifiers delivering up to 100 watts (presumably the huskier European variety.—*Editor*) per pair of tubes. The circuit described has been conservatively designed and time-tested over several years.

A number of excellent output transformers are available in the US that can be used with the circuits given.

Baxandall 5-watt amplifier

This circuit, developed by P. J. Baxandall, appeared in *Wireless World*, March, April and June 1957.

While the present trend is toward higher and higher power outputs, there will always be some interest in a small, simple unit capable of delivering a few clean watts of audio. Fig. 1 shows the circuit of such an amplifier. It uses only three tubes and a rectifier. The first half of an ECC81/12AT7 is used as a voltage amplifier and is followed by the second half of the same tube in a split-load circuit. This drives the output EL84's, and it is here that the amplifier departs from common design. The push-pull output works class A, without grid current. This arrangement is rarely used because of its poor efficiency. However, it offers some very practical advantages from the viewpoint of distortion and, more important, ease of output transformer design—leakage inductances are much less critical.

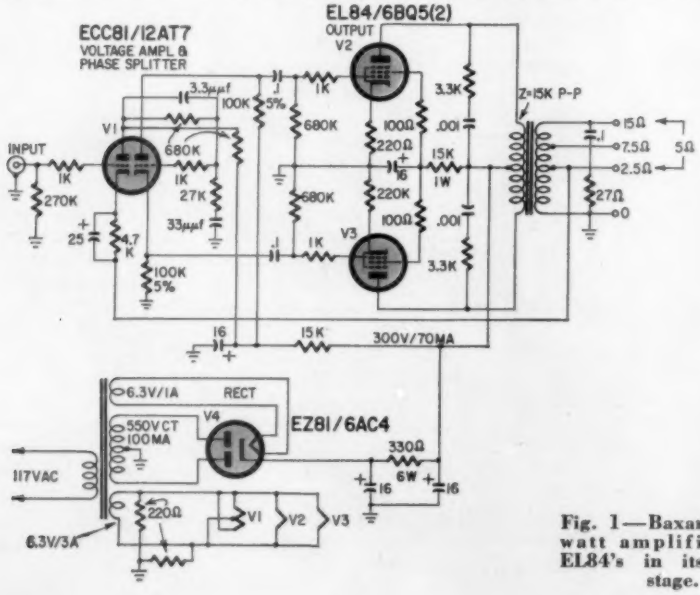


Fig. 1—Baxandall's 5-watt amplifier uses EL84's in its output stage.

The circuit has a number of interesting details that improve performance and stability. First, an overall feedback loop connects the 2.5-ohm output tap to the input cathode, providing 24 db of feedback. This brings the damping factor to about 20, reduces the apparent internal impedance to 0.7 ohm seen from the output and improves the response curve. Square-wave tests at 5,000 cycles show only a small overshoot.

The coupling between the first plate and second grid of the ECC81 is compensated for high frequencies. Three R-C circuits are connected to the output transformer: one across the 15-ohm secondary, and one across each half of the primary. The output tubes are separately biased by unbypassed cathode resistors. This introduces extra feedback and improves the linearity. Suppressor resistors in all control and screen grid circuits prevent parasitic oscillations.

The power supply is conventional and delivers 300 volts at 70 milliamperes. Note the grounded artificial center tap on the heater winding. The circuit in Fig. 1 requires a 4-volt rms signal input for 5 watts output. Sensitivity can be increased to develop the same output with only 1.4 volts input by connecting a 50-μf 25-volt electrolytic across each output cathode resistor and by a minor modification in the feedback loop. Connect 180- and 100-ohm resistors in series between the 2.5-ohm output tap and

ground—the 100-ohm resistor is on the ground end of the string. Connect the feedback line to the junction of the two resistors.

A 10-watt unit

This amplifier can probably be considered as being on the borderline of hi fi, mainly because of the small output transformer used. It was described by P. Ramain in *Toute la Radio*, January, 1957, under the name ATR 212. Its circuit is in Fig. 2. It uses three tubes and a rectifier. The important voltages are indicated.

One half of a 12AU7 is used as a voltage amplifier. The other half has equal loads in its plate and cathode circuits and drives a pair of EL84's. The feedback loop connects the output transformer secondary to the input cathode through a resistance divider. The bias resistor of the second half of the 12AU7 is not decoupled.

For the output pair, part of the bias resistance is common to both tubes, and part is a balance potentiometer for the stage. The power supply uses a 6X4 to provide 300 volts. Current consumption is 75 ma and goes up to 90 ma at the full power of 14 watts. This may seem to exceed the rectifier rating. However, in actual use peak power is reached only for short times.

Two filters are used, one with a choke for the output stage and driver, and an extra one with a resistor for the input triode and the screens of the output pair.

Fifteen db of feedback is used. At 10 watts, total distortion is 2%. The nominal output power is 10 watts, the maximum output power 14.

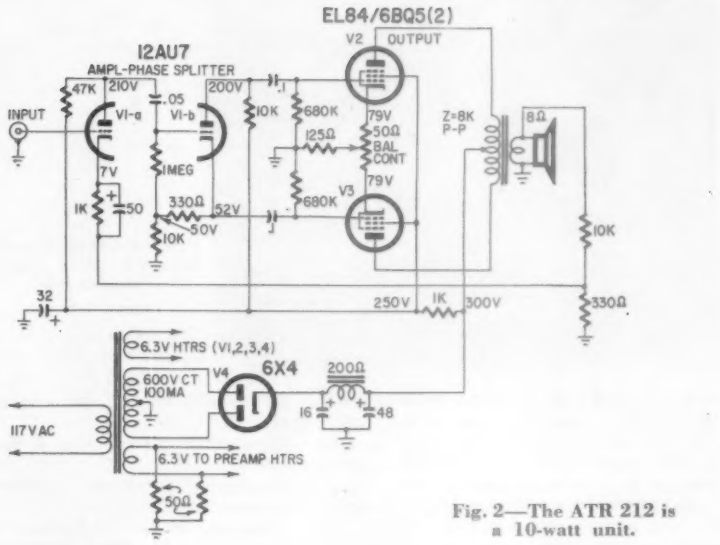


Fig. 2—The ATR 212 is a 10-watt unit.

Printed-circuit amplifier

A 10-watt hi-fi printed-circuit amplifier, produced in France by Coprim, is shown in Fig. 3. The printed-circuit board contains the four tubes and their associated components. The complete amplifier is obtained by adding an output transformer, power supply, and tone control.

The input tube is an EF86/6267 used as a voltage amplifier. It is followed by a 12AX7 second af amplifier and phase inverter in a cathode-coupled circuit. This allows direct coupling between the EF86 plate and the 12AX7's input grid, eliminating low-frequency attenuation and phase shift due to the usual coupling capacitor. Notice the slightly different load resistors in the 12AX7 plate circuits to compensate for the reduced gain of the bottom triode. The output stage uses a pair of EL84's working class AB. Suppressor resistors are used in both control and screen grid circuits.

Feedback taken across the output transformer's secondary is applied to the input cathode through a connecting network. Two other compensation networks are provided, one between the plate of the input tube and B-plus, and another one between plate and grid of the grounded-grid phase inverter.

The power supply is conventional and

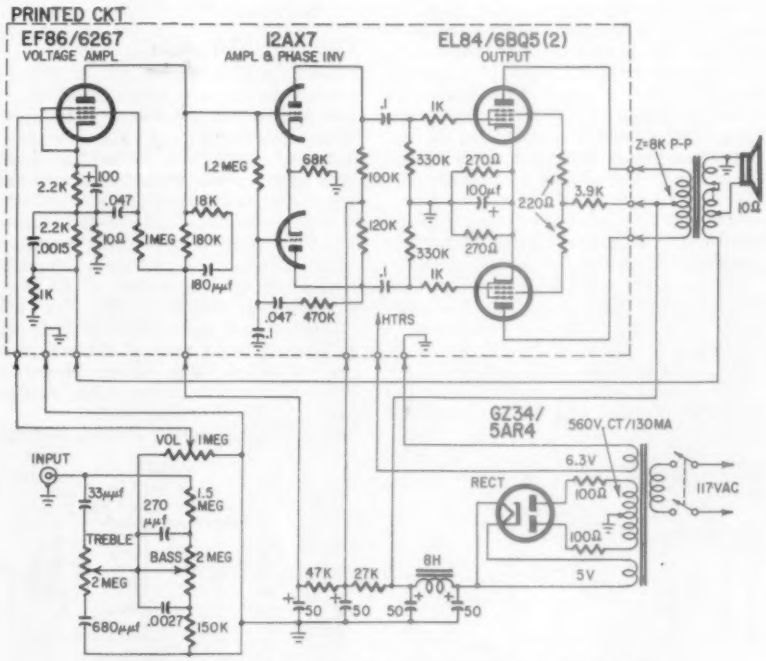
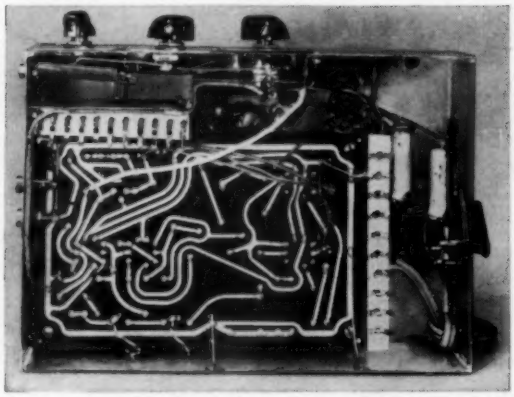


Fig. 3—Circuit of the Coprim printed-circuit amplifier.

Top view of the printed-circuit Coprim amplifier.



Printed circuitry makes building the Coprim unit simple.

heavy filtering is provided, with additional filters for the first two tubes. The two 100-ohm resistors in the plates of the rectifier limit surges of plate current to a safe value.

A simple input circuit is indicated. It has a tone control network with separate bass, treble controls and gain controls. It can be used as a phono input. If a preamp is used, it usually contains the tone and volume controls.

The output transformer is a quality element, but its price has been kept down by dropping all the fancy trimmings and adopting a simple open construction. Under 100 volts at 50 cycles, its primary inductance is larger than 200 henrys and the leakage inductance is 45 mh. The plate-to-plate primary impedance is 8,000 ohms. Maximum power is 12 watts.

Three secondaries are provided. One is used as additional winding for feedback. The other two are connected in series for a secondary impedance of 10 ohms or in parallel for 2.5 ohms.

The overall performance of the amplifier, when loaded with a 2.5-ohm resistor is:

Bandwidth at ±1 db: 14 to 40,000 cycles.

Bandwidth at −6 db: 8 to 80,000 cycles.

Harmonic distortion at 400 cycles at 10 watts: 0.8%.

Intermodulation distortion, 4-to-1 ratio of 40- and 10,000-cycle frequencies, at 10 watts: 0.5%.

Complete hi-fi chain

One of the specialists of the hi-fi market in France, Radio-Saint Lazare, has put out an interesting combination of equipment, evolved over a number of years of experience. It includes a common preamp and a choice of two basic amplifiers, with nominal powers of 10 and 25 watts. The RSL 12-25 preamp is a rather sophisticated affair containing four tubes. The 10-watt amplifier, Symphonie 2, uses a pair of EL84's in a class-AB output stage. The more powerful and more expensive 25-watt Pansonic uses a pair of EL34's in the output stage. The three pieces are rather elaborate units with excellent performance characteristics.

Fig. 4 is the preamp circuit. Basically, it contains a low-noise EF86 voltage amplifier for low-level inputs. It is switched out for normal level inputs. A separate 12AT7 with switched equalization circuits is used for phono inputs, and a 12AX7 incorporating a Baxandall tone control, and a cathode-follower output stage are common to both inputs.

The low-level EF86 amplifier is fairly conventional, except that it has no cathode bias. Instead, a high-value resistor (12 megohms) is used in the grid circuit. Gain is about 90. The EF86 plate circuit is connected to the NORMAL-LEVEL INPUT through a switch incorporated in the jack. A common potentiometer adjusts the gain for both inputs.

The phono amplifier is a double-triode 12AT7. It provides a gain of about 70 and contains the equalization circuits. Both triodes are biased by the grid current flowing through the high-value grid resistors.

The first triode has a plate-to-grid feedback loop to boost the bass. Switching the capacitor provides for 78-rpm (bass boost starting at 500 cycles) and long-playing records (bass boost starting at 1,000 cycles). A more sophisticated circuit is unnecessary, the spread between different recording characteristics being smaller than 3 db.

A better control is necessary for the treble. It is obtained through the six-position switch in the coupling between the two triodes. The values are such that attenuation at 10,000 cycles increases by 3-db steps.

In the low-level amplifiers, only high-quality low-noise resistors are used in grid and plate circuits. The outputs of these two stages, independently adjusted by two potentiometers, are mixed at the input grid of the 12AX7 tone control stage. The coupling between the

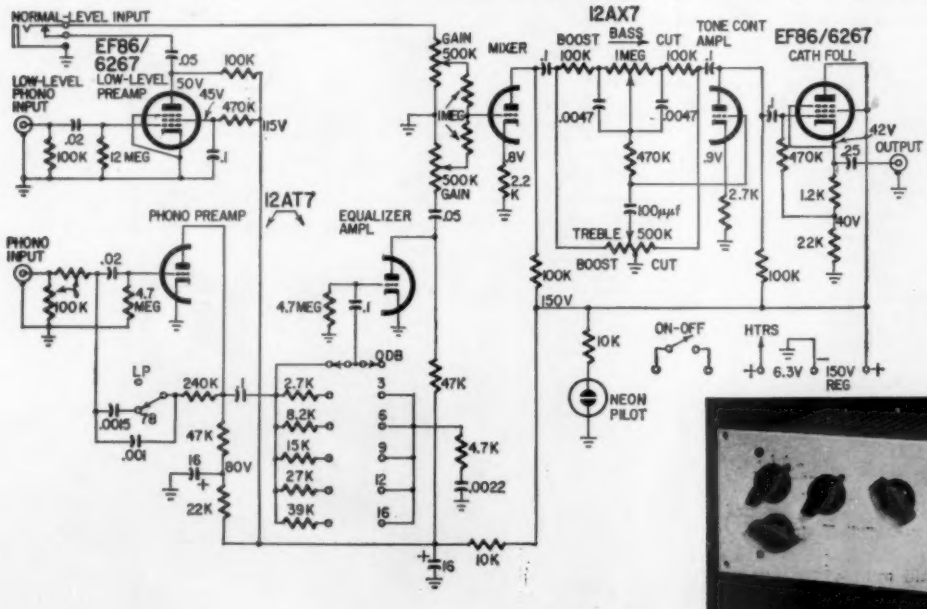
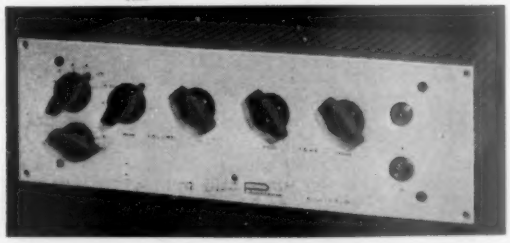


Fig. 4—The RSL 12-25 preamp matches both the 10- and 25-watt amplifiers made by this manufacturer.



triodes of the 12AX7 contains the separate bass and treble controls of the Baxandall circuit. It assures approximately 20 db of boost or cut at 20 and 20,000 cycles. Some feedback is provided by the unbypassed cathode resistors in both triodes.

Often, the distance between the preamp and amplifier is great. The interconnecting shielded wire then has a large capacitance and this, of course, is detrimental to the high frequencies. To obviate this, an EF86 cathode follower provides a low-impedance output.

Besides the shielded wire carrying the signal, the preamp is connected to the amplifier by a multiconductor cable terminated in a standard octal plug. This cable carries the 6.3-volt heater and the stabilized 150-volt B-plus lines provided by the amplifier. It also carries line voltage to the on–off switch, thus permitting the amplifier to be controlled remotely from the preamp's front panel.

Preamp characteristics are:

Phono input: 6 mv for 1-volt output; response flat within 2 db from 1,000–20,000 cycles; signal-to-noise ratio 58 db for 1-volt output and flat tone position.

Low-level input: 4 mv for 1-volt output; response flat within 2 db from 30–16,000 cycles; signal-to-noise ratio 60 db for 1-volt output.

Normal-level input: 250 mv for 1-volt output; response flat within 2 db from 20–60,000 cycles; signal-to-noise ratio 75 db for 1-volt output.

Tone control: +19 to −18 db at 20 cycles; +16 to −18 db at 20,000 cycles.

Matching low-power amplifier

The 10-watt amplifier following the preamp uses four tubes, a rectifier and a voltage regulator. Its circuit is shown in Fig. 5. The input voltage amplifier is a low-noise EF86, triode-connected, which drives directly a cathode-coupled phase inverter 12AX7. This is followed by the output pair of EL84's working class AB. The output stage balance is adjusted by the cathode potentiometer. The output circuit is Ultra-Linear. The output transformer secondary has multiple windings, and the usual impedances are readily obtained through a switching arrangement. Feedback (20 db) is taken across the 15-ohm winding and applied to the input cathode. Suppressor resistors are used in the control and screen grids of the output stage.

The power supply uses a standard transformer and a medium-power rectifier. Filtering is thorough, additional filters being used for the first two tubes. A neon voltage regulator provides stabilized B-plus, at 150 volts for the preamp.

The heater winding is grounded through a 50-ohm potentiometer, adjusted for minimum hum. Actually, the arm of the pot is not connected to ground, but to 25 volts positive. This simple arrangement further minimizes hum. The important voltages are indicated on the diagram.

Performance figures are:

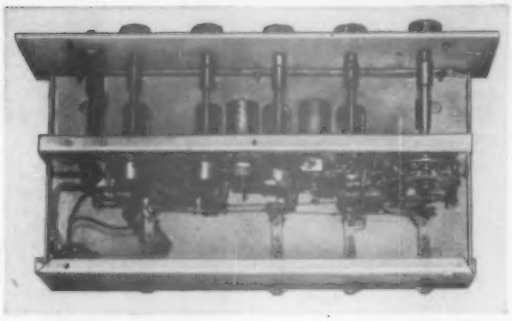
Maximum output power 12 watts.

Nominal output power 10 watts.

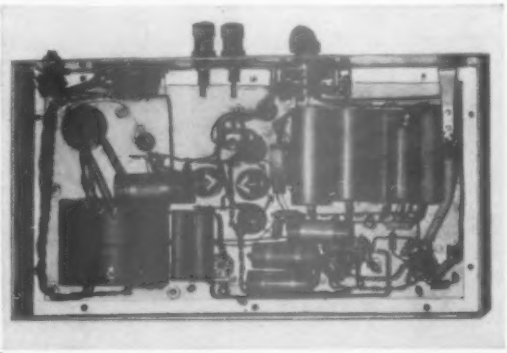
Frequency response flat from 20 to 50,000 cycles, and 3 db drop at 10 and 170,000 cycles.

Sensitivity 0.6-volt input for 10 watts output.

Distortion 0.25% at 10 watts and 1% at 12 watts.



A look at the internal works of the RSL 12-25.



Under the chassis of the Symphonie.

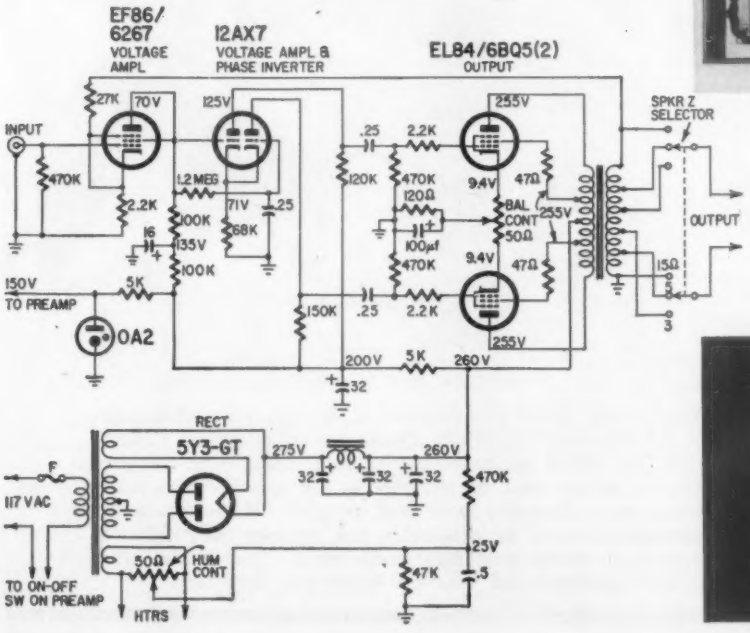
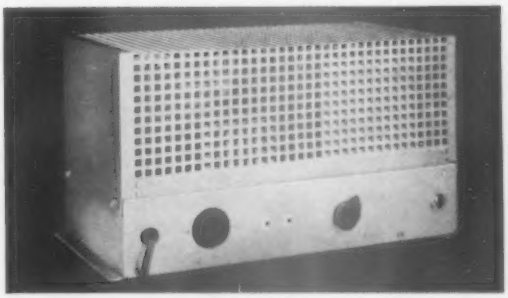


Fig. 5 — The 10-watt Radio-Saint Lazare Symphonie (front view shown below) has the added luxury of a voltage-regulator tube.



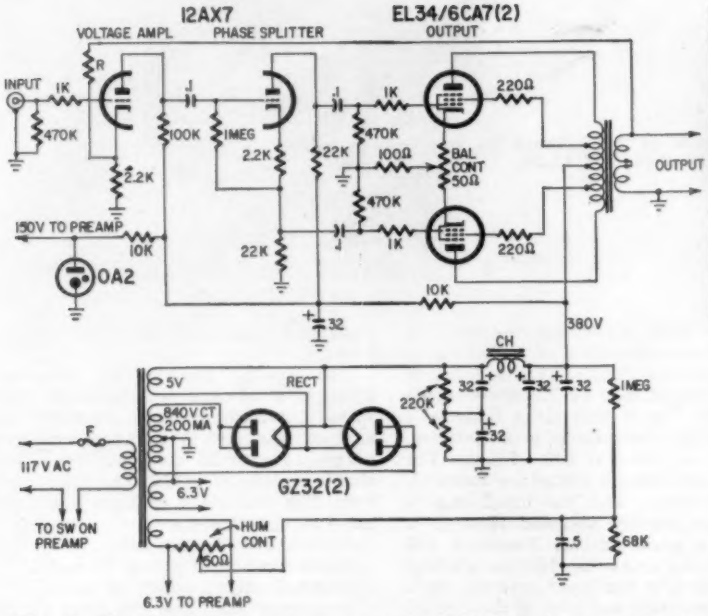
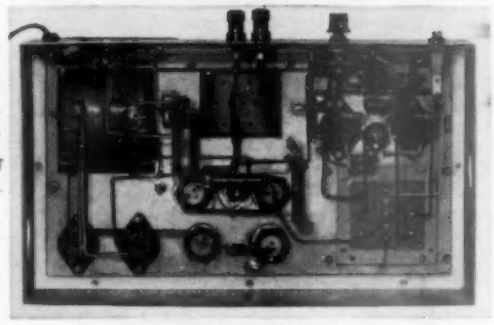


Fig. 6—The 25-watt Pansonic uses popular EL34's in its output stage.



Pansonic amplifier has a neat wiring layout.

Noise 80 db at nominal output.

25-watt basic amplifier

This 25-watt amplifier can also be connected to the Radio-Saint Lazare preamp. It uses three tubes, two rectifiers and a voltage regulator (see Fig. 6). The first triode of a 12AX7 is a voltage amplifier. It is followed by the second triode of the same tube, in a split-load circuit. This drives the output pair of EL34's, balanced with the help of the cathode pot. The output circuit is an Ultra-Linear type. The output transformer has two secondaries. They can be parallel- or series-connected and provide 3.5- and 15-ohm impedances.

Feedback is taken across output transformer's secondary and applied to the input cathode through resistor R. This resistor is 22,000 ohms for a 15-ohm output and 10,000 ohms for a 3.5-ohm output. Suppressors are used in the control and screen-grid circuits of the output pair and in the input grid.

The power supply uses a sturdy transformer and two medium-power rectifiers. This arrangement is preferred to a single high-power rectifier. Good filtering is provided. Since the B-plus reaches 400 volts, the input capacitance for the filter is made up of two capacitors in series for safety. A voltage-regulator tube provides a stabilized 150 volts for the preamp.

Performance figures are:

Maximum output power 30 watts.

Nominal output power 25 watts.

Frequency response flat from 20 to 50,000 cycles, down 3 db at 15 and 120,000 cycles, down 6 db at 10 and 140,000 cycles.

Feedback 10 db.

Sensitivity 0.8-volt input for 25-watt output.

Distortion 0.5% at 25 watts.

Noise −90 db at nominal output.

The design is very conservative throughout. For example, the voltage at the EL34's anodes is only 380.

The photograph shows the wiring under the chassis. Its appearance is similar to that of the 10-watt amplifier, except that it is larger and much heavier, because of the large power transformer and filter choke.

The European tubes used in all the diagrams are readily available in this country; for example, they are marketed by Amperex. Similarly, a number of excellent output transformers for EL84's and EL34's, both standard and Ultra-Linear types, are available from many manufacturers. END

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STEREO PHONO CARTRIDGES

Part I—Ceramic and crystal types including the Astatic Soundflo, Columbia SC-1, E-V series 20 and series 60, Erie Sterieo, Ronette BF-40, Sonotone 8T, and Webster Electric SC-1D

By JULIAN D. HIRSCH

WHEN the Westrex stereo disc system was announced last fall, there were no commercial cartridges designed for stereo disc reproduction available, nor were there any commercial records available. The initial demonstrations of the Westrex system were made with special records cut by Westrex, using special reproducers of their design and manufacture.

Shortly afterward, Fairchild announced its model 603 stereo pickup, but the $250 price tag made it unsuitable for the average hi-fi enthusiast. Not long after the announcement of the Westrex development, Audio Fidelity began to issue stereo discs, and at this time they are available from several manufacturers. Large stereo catalogs are expected in the near future.

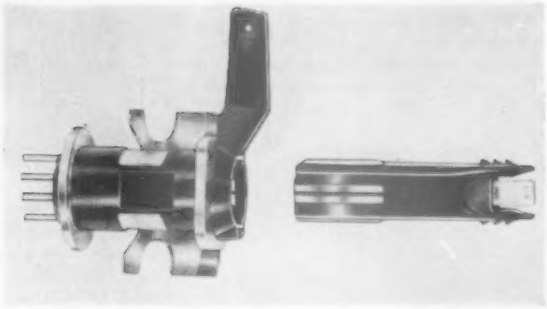
Since the general acceptance of the Westrex (or so-called 45/45) stereo system, there has been a flurry of activity on the part of pickup manufacturers to develop suitable cartridges which could be sold at a reasonably low price. At the time of writing, at least 15 makes of stereo cartridges are advertised for sale, with delivery either immediately or within the next several months.

It appears that anyone planning to build or buy a stereo system—or to convert his present system to stereo—will face a confusing choice from among a large group of cartridges. This situation closely parallels the present one with conventional (monophonic) cartridges, except that the stereo field is so new that few people have any experience to aid them in making a selection.

In this and the following article, a number of the stereo cartridges currently available will be described and their performance specifications presented to the extent that they have been made public. This information has been obtained directly from the manufacturers, and no attempt has been made to compare the cartridges' performance.

The reader who is not familiar with the Westrex stereo disc system (and the reader who *is*, for that matter) is referred to the excellent article by Norman Crowhurst ("How the Stereo Disc Works") in RADIO-ELECTRONICS, July, 1958. Most of the cartridges described in these articles are basically similar to those illustrated in that article.

Stereo cartridges, like the monophonic types we are familiar with, fall into the categories of *amplitude-responding* and *velocity-responding* types.[1] So far there are approximately equal numbers of both types available. The ceramic and crystal cartridges, which fall into the first category, are generally priced well below the magnetic cartridges. In most cases, they are aimed at a low-cost mass market. Some of them, however, are good enough to appeal to the audio hobbyist. Their level and frequency response characteristics are similar to those of monophonic ceramic cartridges, and they will be played through the "crystal or ceramic" amplifier inputs.



The Astatic Soundflo stereo cartridge.

In this article the ceramic and crystal types of stereo cartridges will be described. The listing is in alphabetical order by the manufacturer's name.

Astatic Soundflo

The Astatic Soundflo stereo cartridge is a low-priced unit aimed at the mass consumer market. It is a plug-in type, so the entire active element of the cartridge is replaced with the stylus. The turnover type element plugs into a holder which mounts in any standard arm with 7/16- or ½-inch mounting centers. A lever on the holder rotates the cartridge to place the desired stylus in playing position.

The rated frequency response is 20–15,000 cycles. The nominal output is 0.5 volt. A choice of stylus combinations is available—0.7-mil and 3-mil sapphires, a 0.7-mil diamond and 3-mil sapphire or a pair of 0.7-mil sapphires. The latter combination effectively doubles the useful life of the cartridge where only microgroove records will be played, without requiring an investment in a diamond.

Compliance in both vertical and lateral planes is 2×10^{-6}cm/dyne. The rated tracking force is 5–7 grams. Channel separation (crosstalk) is 25 db.

A unique feature of the Astatic cartridge is the complete separation between the two ceramic elements. Most stereo cartridges use a common ground for the two channels. The Astatic Soundflo has *four* output terminals instead of the usual three. Therefore, the two channels may be completely isolated electrically. This can be advantageous when using ac–dc amplifiers, since there is less likelihood of ground loops and resulting hum problems. Also, the two channels can be phased at the cartridge rather than at the speaker.

The net price of the Astatic cartridge is approximately $4.10 with sapphires and $12 with a diamond–sapphire combination. The cartridge only, less the mount, is about 60¢ less. At the time of writing, only tentative prices were available, and actual prices may be considerably different from those quoted here.

Columbia model SC-1

The Columbia SC-1 is a dual-element ceramic type with a single replaceable stylus. The stylus assembly is mounted with a single small screw. The cartridge mounts on standard 7/16- or ½-inch centers.

The weight of the Columbia SC-1 is 5.5 grams. Its frequency response (relative to the RIAA characteristic) is 30–16,000 cycles within 2.5 db. The nominal output voltage is 0.4 volt. It is

[1] "Modern Phono Cartridges," Parts I–IV, J. D. Hirsch, RADIO-ELECTRONICS, April–July, 1957.

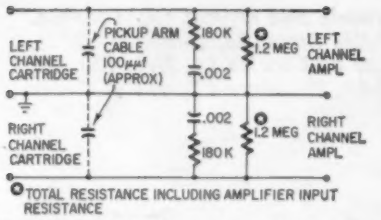
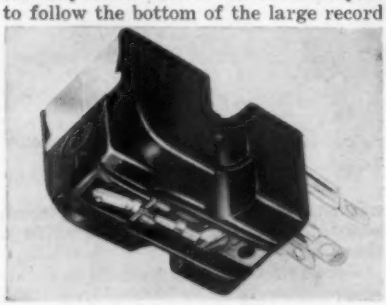


Fig. 1 — Equalizing network for the Columbia SC-1 stereo cartridge.

supplied only with a 0.8-mil diamond stylus. The lateral and vertical compliance is 2×10^{-6} cm/dyne. Recommended tracking force is 5–7 grams. Minimum channel separation is 20 db.

The stylus is coupled to the ceramic elements through a positive mechanical linkage providing a 4-to-1 lever action. The manufacturer recommends this cartridge for playing 78-rpm as well as microgroove records. The low mechanical impedance allows the 0.8-mil stylus to follow the bottom of the large record



The Columbia model SC-1.

groove without skidding and with low needle talk.

For correct equalization of the RIAA recording characteristic, the Columbia SC-1 should be terminated in the network shown in Fig. 1.

Electro-Voice series 20

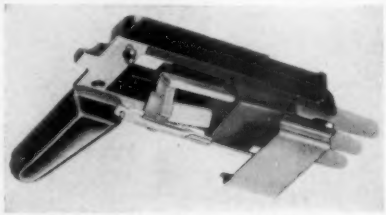
The first ceramic stereo cartridge to appear on the market was the E-V model 21. The basic structure of this cartridge was clearly described by Crowhurst in the article referred to earlier.

The model 21 is a single-stylus unit, available with either diamond or sapphire stylus. A dual-stylus turnover cartridge, the model 26 ST, is also available. It is effectively two cartridges, with the entire cartridge body rotating in its mount to place either the microgroove or 3-mil stylus on the record.

The stylus is mounted at the end of a light, hollow metal tube which is supported at its other end by a thin wire extending along the axis of the tube. Since the stylus support has a symmetrical cross-section, its compliance is the same in both vertical and lateral planes. The entire stylus assembly clips onto the plastic body of the cartridge near the terminals at the rear. The hollow stylus tube rests in a compliant wedge-shaped block which also is in contact with the two ceramic elements. The 45/45 mounting of the elements can be clearly seen in the photograph of the cartridge without its plastic case.

The E-V model 21 cartridge weighs only 2-4 grams, and the model 26 weighs 2.6 grams. The frequency response, referred to the RIAA characteristic, is within 2.5 db from 20 to 16,000 cycles when the cartridge is terminated in a 3-megohm load resistance. Bass response may be extended further, down to 10 or 15 cycles, by increasing the load resistance to 5 to 9 megohms. The nominal output voltage is 0.5.

The model 21 is available with a 0.7-mil stylus, either sapphire or diamond. The model 26 is available with a 0.7-mil and a 3-mil sapphire or a 0.7-mil dia-



Cutaway view of the Electro-Voice turnover stereo job.

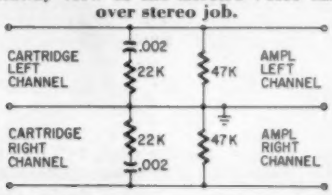


Fig. 2—Network for magnetic equalization of E-V series 21 or 26 stereo cartridge.

mond and a 3-mil sapphire. The vertical and lateral compliance of both types is 2×10^{-6} cm/dyne, and the recommended tracking force is 6 grams. The channel separation of the E-V cartridges is 20 db or better over most of the useful frequency range.

The E-V stereo cartridges feature a vertical rumble eliminator, which reduces the low-frequency response in the vertical plane. This appears to be done by a vertical compliance in the mounting of the ceramic elements. Since the full frequency range is covered by the lateral output, which is common to both channels, there is no loss of fidelity, and it is stated that no stereo effect is sacrificed since very low frequencies do not contribute to directional effects.

The net price of the model 21 cartridge is $9.90 with a sapphire stylus and $19.50 with a diamond stylus. The turnover model 26 is priced at $12.50 with two sapphires and $22.50 with a diamond–sapphire combination.

If it is desired to use the magnetic (equalized) inputs of the preamplifiers, it is possible to terminate the two cartridge outputs in the simple R-C network shown in Fig. 2. This reduces the output voltage to levels comparable to that of magnetic cartridges, and gives a response characteristic similar to that of a magnetic cartridge. Electro-Voice manufactures a magnetic adapter which incorporates the necessary equalization for both channels, as well as a selector switch for reversing channels or for monaural operation.

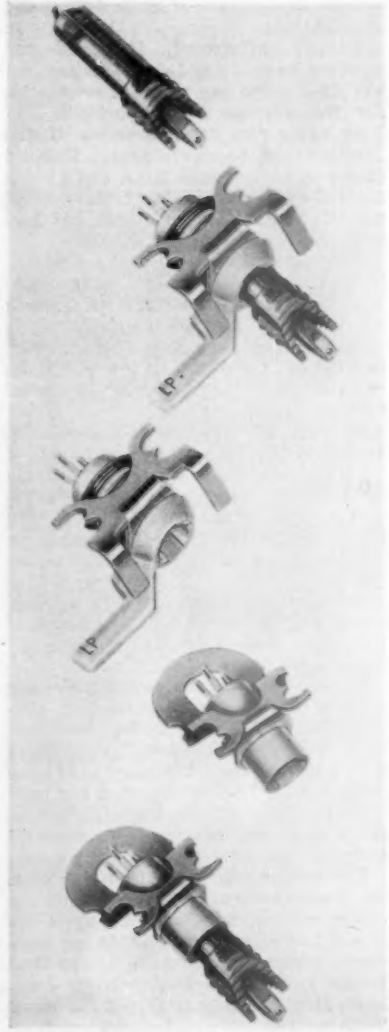
In the near future, the 21M and 26M cartridges will be available. These are similar to the standard 20 series units except that they are intended to plug directly into magnetic preamplifiers without the external equalization network we have described.

"Power-Point" cartridges

The E-V Power-Point cartridges are low-cost units for use in inexpensive home phonographs. They are now available in a stereo model, the model 61, with two 0.7-mil styli and the model 66 with a 0.7-mil and a 3-mil stylus.

These cartridges are designed to plug into a holder which mounts on standard ½- or 7/16-inch centers. The entire element is replaced when the stylus becomes worn. Two types of holder are available, one for fixed and the other for turnover cartridges.

In general, the specifications for the series 60 cartridges are similar to those



Electro-Voice stereo Power Points and mounts.

of the series 20, except that the high-frequency response is not as extended and channel separation is only 15 db.

The series 60 cartridges are priced at $3.50 with two sapphires and $11.50 with a diamond–sapphire stylus combination. The turnover and fixed holders cost 60¢ and 30¢ respectively.

Erie "Sterieo" cartridge

The Erie Sterieo cartridge is a plug-in design in which the entire element is

The Ronette Binofluid BF-40.

replaced together with the worn stylus. The mounting fits pickup arms with standard centers.

It features a single ceramic element, unlike the other units just described, which have two elements. No details have been released on how the element is driven on two mutually perpendicular axes to obtain separate outputs.

The cartridge weighs 3 grams. Its response above 1,000 cycles is flat within 3 db through the audio range. When terminated in the recommended 2-megohm load resistor, the response of the Sterieo cartridge falls off gradually below 1,000 cycles, and is down 7 db at 100 cycles. A small amount of bass boost from the amplifier's tone controls compensates for this drop. The nominal output voltage is 0.4.

A choice of two LP styli or an LP–78-rpm combination stylus is available, either in sapphire or diamond–sapphire. The cartridge turns over in its mount to place the correct stylus on the record. The compliance is greater than 1.7×10^{-6} cm/dyne, and the recommended tracking force is 5–6 grams.

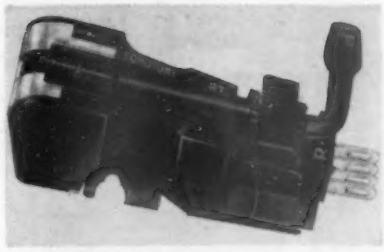
The channel separation is at least 20 db from 30 to 8,000 cycles. Above 8,000 cycles, the crosstalk increases gradually to about 12-db separation at 15,000 cycles.

Ronette BF-40

The Ronette BF-40 Binofluid stereo cartridge employs two humidity-proofed crystal elements, driven through a direct mechanical coupling, by a single stylus (see Fig. 3).

When terminated in the recommended 500,000-ohm load resistance, it is self-equalizing for the RIAA characteristic within 3 db from 30–15,000 cycles. The output is approximately 0.35 volt per channel.

The stylus assembly is of the snap-in replaceable type. It is available with a 0.75-mil stylus, either sapphire or diamond. The compliance in both vertical and lateral planes is relatively high, 3.5×10^{-6} cm/dyne. A tracking force of 5.5–6 grams is recommended in record



Sonotone's 8T stereo turnover unit.

changers. Less force would be needed in a better quality arm. Ronette claims a very high channel separation, 26–28 db at 1,000 cycles and 20–22 db at 10,000 cycles.

The net price of the Ronette BF-40 with sapphire stylus is $12. With a diamond stylus it is $18.60. It is also available integrally mounted in a Ronette arm at an additional cost of about $4 for the 12-inch arm and $5.60 for the 16-inch arm.

Sonotone model 8T

The Sonotone 8T is the stereo counterpart of the well known 3T monophonic cartridge. It contains two ceramic elements, driven by a single stylus. The stylus assembly is of the simply replaced clip-in turnover type used in the older 3T series.

The weight of the Sonotone 8T is 7.5 grams. It mounts in any arm that has standard 7/16- or ½-inch mounting centers.

Frequency response of the 8T is smooth (within 2.5 db) from 20–12,000 cycles, with a gradual rolloff above 12,000 cycles. The nominal output voltage is 0.3.

The turnover stylus has 0.7-mil and 3-mil jewels. These are available as two sapphires, a 0.7-mil diamond with a 3-mil sapphire, or two diamonds. The compliance is 2×10^{-6} cm/dyne. Rated tracking force is 5–7 grams. The recommended load resistance is 1 to 5 megohms. Low-frequency response is better with the higher values. Channel separation is 20 db at 1,000 cycles and somewhat less at lower and higher frequencies.

The Sonotone 8T features a special mounting bracket which reduces vertical rumble. The cartridge mounting bracket has a cantilever extension which is the only part of the cartridge to actually contact the arm. This extension of the mounting bracket is cut away so as to have a relatively high vertical compliance, and acts as an acoustic trap or filter which reduces the low-frequency response in the vertical channel. It has no effect on the frequency response of the lateral channel.

The net price of the Sonotone 8T is $8.70 with sapphire styli, $14.70 with a diamond and a sapphire, and $20.70 with two diamonds.

Webster-Electric SC-1D

The Webster-Electric SC-1D is a single-stylus plug-in cartridge. It fits a mounting clip which may be installed in any standard arm. The entire cartridge element may be plugged in or out without tools, and the stylus may be replaced independently of the cartridge element.

Its frequency response is 30–15,000 cycles, and the output voltage 0.5. The stereo stylus is a 0.7-mil diamond. A special cartridge insert, with a single ceramic element and a 3-mil sapphire stylus, is also available for playing 78-

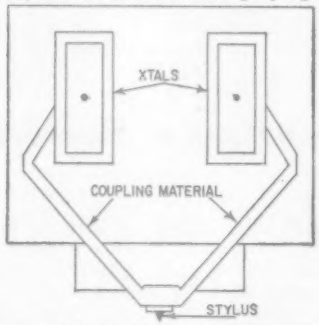


Fig. 3 — Mechanical coupling arrangement of Binofluid BF-40.

rpm records. The recommended tracking force is 5–7 grams.

The net price of the Webster-Electric model SC-1D is $14.70 with 0.7-mil diamond. The 78-rpm insert with 3-mil sapphire stylus is priced at $4.50.

Summary

This listing of ceramic stereo cartridges is necessarily incomplete because new ones are continually appearing. In addition, specific details as to the internal construction are not available for many of the newer types. Prices were those in effect on July 1.

It is already apparent that there is as much diversity in design and appearance among the stereo cartridges as among the older monophonic types. It is interesting to see that the general price level of the stereo types is no higher than that of monophonic cartridges. The cost of the diamonds appears to have come down appreciably (especially when the 0.7-mil tip radius is considered), so in many cases the stereo cartridges are cheaper than the single-channel counterpart with a diamond stylus.

The increased vertical and lateral compliance of the stereo cartridges, necessary for avoiding damage to the stereo grooves, may make them superior to the older cartridges for reproducing standard LP records. The smaller stylus radius should also provide better tracking, particularly of heavily modulated inner grooves.

It would seem reasonable for anyone considering the purchase of a ceramic or crystal phono cartridge to buy a stereo type, even if he has no immediate plans for a stereo disc system. This would be the case even if they were more expensive than the monophonic types, instead of less expensive.

In next month's article, a number of magnetic stereo cartridges will be described.

TO BE CONTINUED

improving RADIO and PHONO AMPLIFIERS

If it's a push-pull job, the simple changes mentioned here will make a startling improvement in the way the unit sounds

By NORMAN H. CROWHURST

I AM often asked whether anything can be done to improve a relatively inexpensive radio, phono or combination hi fi, by adding feedback to the amplifier "or something." The answer is, "It depends."

If you bought an inexpensive hi-fi radio–phono combination or just the phono complete in a single cabinet, the speakers are probably inadequate. To improve quality appreciably, you will need better speakers mounted in a separate enclosure. It's no good having a first class amplifier and then feeding it into one or more small speakers housed in the same cabinet with the phono combination.

The circuit used determines how much the amplifier can be improved. Most radio–phono circuits that feed a single speaker have a single-ended output stage, usually using a 6AQ5 or 6V6-GT. There isn't too much that can be done to improve this setup. The single-ended output transformer usually has a rather high-resistance primary, which makes it relatively inefficient and blocks successful feedback action even supposing you can find some way of supplying it. The kind of amplifier that can be improved is that using push-pull output tubes, usually to feed two or more small speakers.

Adding feedback

Most push-pull 6AQ5 or 6V6-GT circuits use a driver circuit of the type shown in either Fig. 1 or Fig. 2. Both arrangements use a twin triode, but one is a split load (Fig. 1) while the other is a paraphase phase inverter (Fig. 2). Immediately preceding this tube, you will usually find the volume control or the tone control. It is not feasible to apply feedback over more than the output tube and this twin triode.

The method of applying feedback depends on the driver circuit and the type of twin triode already in the circuit.

Let's take the split-load inverter first. Before we can apply negative feedback, we need more gain in this stage. Otherwise, the feedback will reduce the gain and the amplifier will not give enough output from the available input. If the twin triode is a 12AU7 or a 12AT7, additional gain can be picked up by using a 12AX7 instead.

Circuit values, resistors in particular, will need changing to make the most of the tube change, because the coupling resistors found with a 12AU7 or 12AT7 will be too low to give the full gain of which the 12AX7 is capable. To improve stability, the tubes can also be rearranged for direct coupling in place of the R-C coupling used in most of these circuits.

If the circuit is already direct-coupled, no change, other than modifying the resistor values, is necessary. Simply fit in the values shown in Fig. 3. This will produce satisfactory operating conditions for the 12AX7 as a direct-coupled amplifier–phase inverter.

Now we apply the feedback. This is done by connecting one end of the output transformer's secondary to ground and the other end through a feedback resistor to the 1,000-ohm amplifier stage bias resistor. For a start, try 100,000 ohms for the feedback resistor.

The amplifier may oscillate furiously. This indicates that the phasing is wrong. The simplest method of remedying this is either to ground the opposite end of the transfomer secondary and connect the resistor to the end that was grounded, or reverse the primary connections to the output tube plates.

Having made the change in phase, where necessary, the amplifier should be stable, and the gain less than when the 12AX7 was first inserted and values changed. Now adjust the value of the feedback resistor until there is a comfortable margin of gain for operating on radio, phono or both, but not more than you need.

The lower the resistor value, the more the negative feedback and the better the cleanup action. But if you use too much feedback (too low a resistance value), you will not get enough output and may run into instability. If you find the amplifier becomes unstable at either low or high frequencies, increase the value of the feedback resistor until the amplifier becomes stable (a scope or audio vtvm will tell you when the amplifier is stabilized). But the amount of extra feedback you can use, while maintaining the original gain of the amplifier, usually will not cause any instability.

Next we will consider the set in which the amplifier and phase splitter is already a 12AX7. Here we can't increase gain by simply changing the tube and resistor values. We already have the twin triode that gives the most possible gain. So this time we use positive feedback to get the extra gain.

The circuit values and wiring changes necessary are shown in Fig. 4. For this purpose, the bottom end of the phase-splitter cathode resistor is returned to the cathode of the amplifier

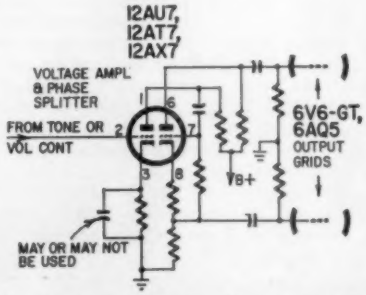


Fig. 1—One basic circuit, used to drive push-pull 6V6-GT or 6AQ5 output tubes, can be improved using the method outlined in this article.

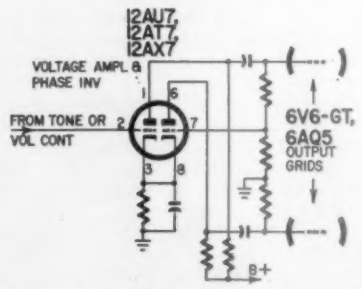


Fig. 2—A little doctoring with increased gain and feedback will improve this common driver circuit.

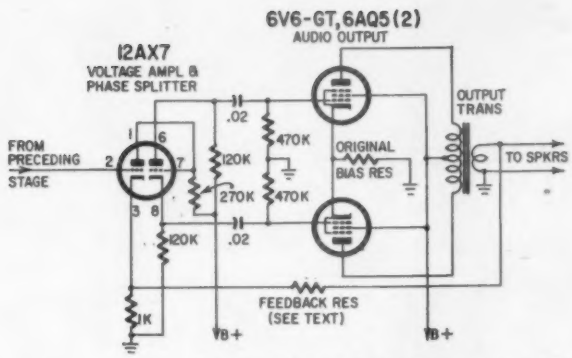


Fig. 3—If the tube in Fig. 1 was a 12AU7 or 12AT7, the circuit can be improved by changing to a 12AX7 with the values shown here and adding feedback.

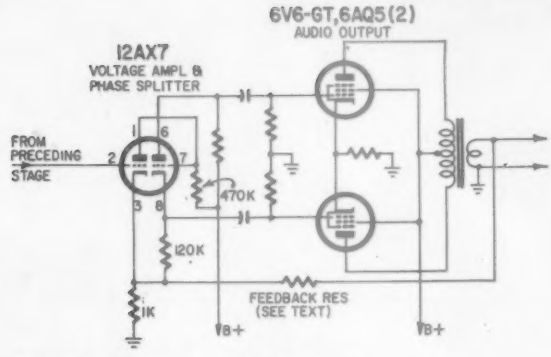


Fig. 4—If the circuit of Fig. 1 already used a 12AX7, use positive feedback to get the extra gain needed for negative feedback. Suitable values are shown.

stage and this provides positive feedback, almost enough to cause oscillation. It will increase gain four or five times.

Now we apply feedback from the secondary of the output transformer, as in Fig. 3, starting with a 68,000-ohm resistor. If the connection first used causes oscillation, reverse one of the transformer windings to stabilize the amplifier and then adjust the feedback resistor until you finish up with about the same gain the amplifier originally had.

Now for the paraphase type circuit (Fig. 2). If the tube is a 12AU7 or a 12AT7, we can get the necessary extra gain by changing to a 12AX7. This definitely involves changes in resistor values. For one thing, the resistors that provide the grid swing for the second tube of the phase inverter will give the wrong voltage—much too high for a 12AX7. So the values shown in Fig. 5 should be used for a 12AX7 paraphase inverter to feed 6AQ5 or 6V6-GT push-pull output.

If the original circuit had a common bias resistor and decoupling capacitor for both halves of the driver, replace them with separate biasing resistors, as in Fig. 5. In this circuit the first cathode cannot be bypassed to ground because it is used for feedback injection. The second cathode should not be bypassed either, to maintain symmetry and to help stabilize the gain of the phase inverter.

Finally, you apply feedback from the secondary of the output transformer to the first cathode, reversing a winding if necessary, and adjusting the resistor to get the right gain. Start with 220,000 ohms for the feedback resistor.

If this circuit originally came with a 12AX7, the only thing you can do is use positive feedback and the only way to do this is to revert to the circuit of Fig. 4. This changes the phase inverter from a paraphase to a split-load type. The values and procedure for adjusting the feedback will be exactly the same as for Fig. 4.

Boosting overload performance

One more step is needed to improve

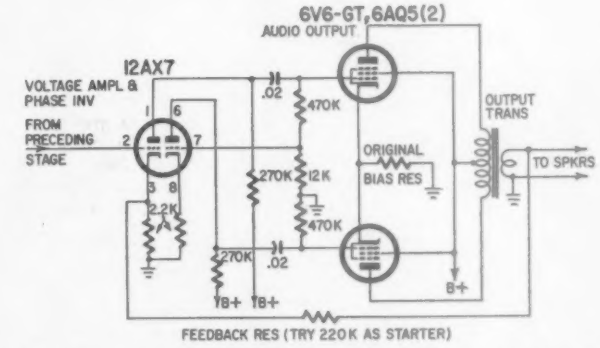


Fig. 5—Values associated with a 12AX7 paraphase circuit when this can be used to pep up the circuit of Fig. 2.

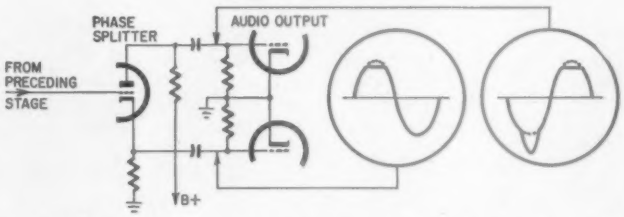


Fig. 6—A particular kind of waveform distortion occurs at overload with a split-load phase inverter.

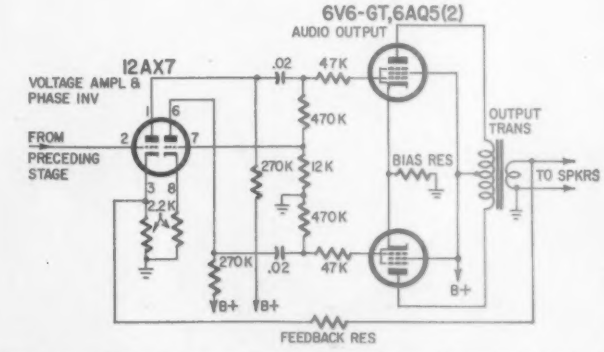


Fig. 7—The paraphase inverter circuit after all modifications have been made.

either of these circuits. When feedback is applied to these amplifiers, it cleans up low-level distortion very well. But adding feedback also means that the amplifier overloads much more suddenly. This causes grid current in the output tubes and sets up serious clipping and crossover distortion immediately after overload occurs.

In the split-load phase inverter the overload effect also causes asymmetry due to bypassing the cathode section of the load and producing a sudden increased amplification in the plate half of the load for this section of the waveform (see Fig. 6).

The remedy for both defects, in either the split load or the paraphase, is to insert a resistor in series with each output tube grid. A 47,000-ohm unit proves satisfactory for this purpose when working with a 12AX7 phase inverter. Fig. 7 shows the series grid resistors added to the paraphase circuit. They can also be used in the same position with the split-load phase inverter or, for that matter, in any similar output stage.

When overall feedback is connected in the correct phase to be negative and to end up with about the same gain the amplifier had originally, these changes should not cause instability or parasitic oscillation.

If any trouble is experienced (checked by looking at the output with a scope if it does not sound "clean at all times), the cause is probably inadequate decoupling in the B-plus supply to the 12AX7. This should be remedied by inserting decoupling, consisting of a 22,000-ohm resistor and a 40-μf 350-volt electrolytic, in the feed to the 12AX7 plates. But this will seldom, if ever, be necessary.

All these changes, when applied to many radio and phono amplifiers will improve their performance considerably. Notably they cut distortion, both harmonic and intermodulation. Harmonic distortion is not very noticeable, but intermodulation is responsible for the rather "muddy" quality these amplifiers give. It has the effect of mixing up all the instruments in the orchestra, so, instead of hearing distinct separate instruments, they all seem to be muddled together. Changing the circuit cleans up the distortion and makes reproduction much crisper and clearer.

Additionally, it improves the amplifier's overload characteristics somewhat, so the distortion is not so noticeable if the volume is turned up too far. Particularly important to this aspect of the improvement are the 47,000-ohm resistors in series with the output-tube grids.

These changes should improve a low cost "hi-fi" set that proved to be not as hi-fi as anticipated, so that the quality of the presentation is much better. Once you have changed the amplifier and added some better speakers, there may be other changes you can make, like getting a better pickup. More about these some other time. END

COVER FEATURE

Covering the full audio range the HFS-2 speaker system is especially suited for stereo hi-fi systems

SPEAKER SYSTEM for the STEREO AGE

By A. STEWART HEGEMAN and NORMAN EISENBERG

STEREO'S coming of age has caused designers to focus new attention on the special factors applying to that type of reproduction. Chief among these factors, which are largely responsible for the "spread" and naturalness of stereo (but which, interestingly, have been given little attention in the past) are omnidirectionality—not merely "fanning out" of the sound but true circular distribution — and linearity of phase shift (constant time delay) in the acoustic transmission system represented by the speaker. Thus the speaker system on our cover this month, the Eico HFS-2, designed by A. Stewart Hegeman, takes into account not only the traditional demands of speaker systems, but also the special requirements of the new art of stereo.

Linear phase shift maintains the temporal spacing of the elements of any transmission—for example, the relationship of overtones in reproduced music. Disturbance of this relationship, while not easy to measure, does constitute a serious intermodulation effect.

To meet the requirements of linear phase shift, the ideal reproducer would be a zero-point source that would radiate a perfect wavefront over the full audio spectrum. Such a reproducer would also be inherently omnidirectional, something like a sphere of infinitely small size expanding and contracting. The same design techniques that make for linear phase shift do, at the same time, make for omnidirectionality.

Omnidirectionality is a problem largely restricted to mid-range and high frequencies. These tones tend to beam, resulting in unpleasantness and lack of naturalness in reproduction, caused by the loss of the spatial characteristics typical of live sound.

Omnidirectionality is important, too, for its ability to re-establish in a small room something of the natural ratio of reflected to direct sound (often as high as 4 to 1) that we hear in the concert hall. Obviously, any reproducer that can approach this ratio correctly will sound more lifelike.

The HFS-2 has been developed to meet these demands as well as the other accepted criteria, such as extended and "flat" frequency response, low distortion and good transient recovery. It is effectively a four-way system. Bass, from 200 cycles down, is generated by the rear of an 8½-inch driver working into a slot-loaded conical horn (more on this later). The front of this driver's cone crosses over at 200 cycles, by virtue of its acoustic relationship with the rest of the system, and continues to respond to about 2,000 cycles.

A mechanical crossover then feeds signals in the range from 2,000 to 8,000 cycles to a free-edge, specially loaded cone, the outer boatlike object just inside (above) the driver in the cutaway photo and the cover picture. The range above 8,000 cycles is electrically divided by a 12-db/octave network consisting of a 1-μf capacitor and a 150-μh coil (Fig. 1), and fed to an independent driver (tweeter) whose design parameters resemble those of the upper mid-range unit.

Tweeter design

This tweeter radiates from both sides of the free-edge steep-sided vertical cone or cornet mounted above the 8½-inch speaker. The outer surface of the cone produces a 360° horizontal radiation pattern. Radiation from the inner surface provides the vertical component

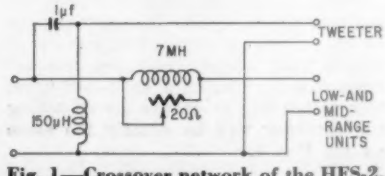
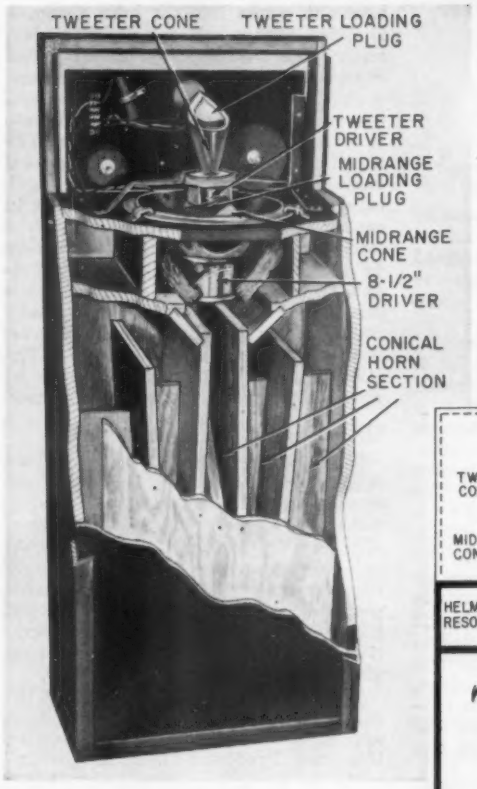
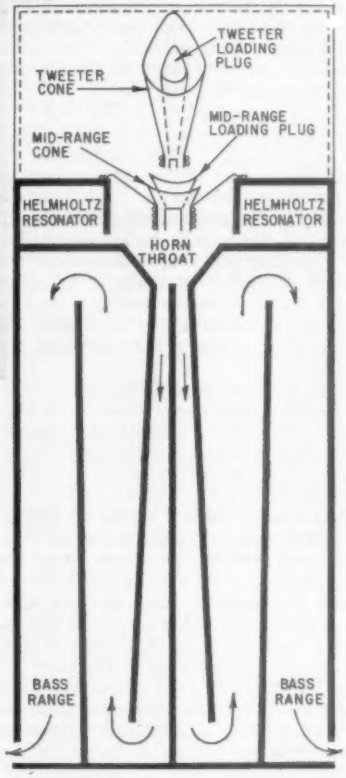


Fig. 1—Crossover network of the HFS-2. (Incidentally, this can be used only with an inherently well-damped system.)



Cutaway model of the Eico HFS-2

Section showing details not revealed in the cut-away photo



for a complete hemispheric dispersion pattern.

If this were a conventional vertical cone with an edge forming a right angle to the voice coil axis, it would have a relatively narrow-band response. What's more, the lateral radiation would all be in one plane while the vertical response would be beamed, not dispersed.

In this design the edge of the cone is so cut as to provide a constantly varying distance between the cone's edge and the voice coil. This broadbands the tweeter's response while smoothing it to avoid undesirable peaks. This shaping also spreads the radiation vertically so that it is not restricted to one plane horizontally.

To enhance this "umbrella" coverage further a rigid and nonmoving "acoustical loading cone" or "plug" is inserted concentrically within the radiating cone. This plug forms an air gap between itself and the inner surface of the radiating cone. This gap acts as a ring radiator. Because of the varying distance between its effective radiating surface and the voice coil, this ring radiator produces a desirable phase displacement between any two or more acoustical elements (air particles) in that gap. As a result of this displacement the radiation pattern from the tweeter takes on a hemispherical shape. An additional benefit from this plug is that it obviates any effects of response peaks or instability which might be caused by radiation from diametrically opposite points on the inner surface of the radiating cone.

Finally, by mounting this configuration literally out in the open (see photograph), a practical omnidirectional sound source is created which represents a close approach to the theoretical ideal of a zero point source.

Mid-range design

The design principles used in the tweeter can be varied to provide correct response over different portions of the frequency range, still retaining the same optimum distribution pattern. In the mid-range reproducer element of the HFS-2 (known in its prototype form as the Hegeman Standard) it was found that the frontal radiation from the cone used for the low-frequency driver provided excellent response from slightly below 200 to above 8,000 cycles. What was needed was to stabilize this response, eliminate any peaks, provide for the same hemispherical radiation pattern as in the tweeter and furnish a means of balancing the mid-range response with the high and low ends.

Another free-edge cone of special shape, with its nonmoving acoustical loading cone, is used to stabilize and smooth the response, as well as to produce the desired hemispheric radiation. The power response of this unit is such that it is inherently almost perfectly balanced with the high and low ends. To adjust this balance a specially designed control—the 7-mh choke and 20-ohm potentiometer of Fig. 1—changes the relative amounts of high- and low-frequency energy fed to the woofer and mid-range driver. With the resistor nearly shorted, all frequencies flow equally into the speaker. With it set near its full 20 ohms, the lower frequencies are favored. Its range provides sufficient variation to balance the system to suit most acoustic environments.

The bass reproducer

In all the literature of high-fidelity, no subject has been discussed and debated more than low-frequency reproduction. Readers of RADIO-ELECTRONICS are thoroughly familiar with the pros and cons of horns as against direct radiators. In selecting a horn for the bass element of this system, considerable weight was given to two advantages: The horn can provide an even wider pattern of sound distribution, and it can couple acoustical energy efficiently to the listening environment from a relatively narrow source (the speaker cone). Horns have their problems, too, but these problems are subject to solution, as we shall see.

Possibly no reproducer conformation has been as much abused in the literature as the conical horn. That type, it has been fashionable to point out, has a rapid rolloff in response and is therefore unsuited for hi-fi applications. What has *not* been pointed out—but what is quite apparent from even a cursory study of published curves—is that the conical horn remains far and away the smoothest responding horn known—even when it is rolling off.

The response curves for different horn shapes are shown in Fig. 2. The

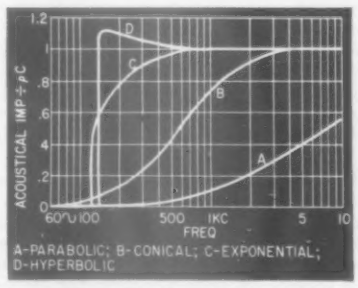


Fig. 2—Conical, hyperbolic, parabolic and exponential horns compared.

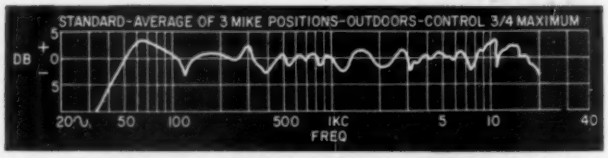


Fig. 3—Frequency response of HFS-2, or Hegeman Standard, speaker system.

conical horn begins to show its merits as a bass reproducer when one investigates carefully the behavior of horns near cutoff frequencies, and the use of horn mouths that are—in theory at least—inadequate in diameter. It is certainly true that the efficiency of a conical horn does begin to roll off at a higher frequency than other horn shapes, but that rolloff is very gradual, very linear. And it is equally true that the conical horn continues to respond—albeit at lower amplitudes—an octave below an exponential horn of equivalent size!

Further, if one accepts the general proposition that sharp changes in amplitude response represent large changes in phase characteristic and that gradual changes indicate that the phase characteristic is more linear, it is obvious that the conical horn must produce less coloration of whatever signals it is reproducing than can either a hyperbolic or an exponential horn. To put it another way: the *smoother* rolloff in efficiency of the conical horn represents a lesser change from the desired linear phase characteristic (so essential to natural reproduction) than is possible with an exponential horn.

There still remains, of course, the problem of horn mouth size for adequate bass response, and the efficiency at the very low end. Any horn has a natural cutoff point, determined by its length, mouth diameter and rate of flare. A horn would require a mouth diameter of 7 feet to reproduce 50 cycles. This is obviously out of the question for practical applications. "Folding" the horn to make it physically shorter and using the corner of the room to lengthen it acoustically do help. But there is a better solution.

Just as in transmission practice it is entirely feasible to replace, for example, a required section of telephone line with a properly devised termination, so acoustically it is possible to replace a section of a horn with a properly devised acoustic termination. At low frequencies, such a termination is represented by a narrow slot. Consequently, by replacing the mouth of a relatively short conical horn with a critically dimensioned slot, it is possible to cause the driver mounted at the horn throat to behave as if it were working into a horn of virtually infinite length.

The slot confines enough air within the horn to build up a suitable resistance for the driver (at the horn throat) to work against. At any point from the slot back to the driver, the air in the now shortened horn presents the same impedance to the driver as if the horn had continued to an optimum length and mouth diameter for frequencies below 30 cycles. Additionally, the acoustic impedance now inside the confined horn produces a greater air pressure within that horn than in the room outside the horn.

As a result of this internal pressure, the slot functions acoustically as if it were many times its own area. Behind it, every movement of the speaker cone sets up relatively high compressions of small masses of moving air. These compressions provide the same acoustic energy as would otherwise be provided by large masses of air under less compression. The higher pressure within the horn—higher with respect to the normal pressure of the atmosphere in a room—results in a high particle velocity in the slot, causing the acoustic energy in the horn to be transmitted to the listening room with the effect and impact of a jet stream. The comparison, by the way, is no mere analogy—as anyone who has held a lit match near the slot during a heavy bass passage can testify!

This high-pressure technique permits getting the lowest bass tones from what might normally be considered a "small" bass driver—an 8½-inch cone.

Efficiency

Slot dimensions are chosen to provide optimum radiation resistance (highest efficiency) at the very low frequency end, just below 30 cycles. These dimensions, fortunately, also provide radiation resistance *below* optimum for the upper bass frequencies, reducing their efficiency to match that of the very low end. In this way, the entire bass line becomes essentially flat. In practice, loading extends to 20 cycles, producing a response that is smooth, full and clean—with no possibility of doubling. The net result, in effect, is a conical horn with no bass rolloff! And because its overall efficiency is comparable to that obtained from the radiators used for mid-range and highs, the entire system has a uniform efficiency throughout its range, as may be seen in Fig. 3.

What's more, the shortened horn length actually improves transit-time characteristics, so that the phase relationships of all bass tones are largely preserved.

The front of the bass driver is open to the same room into which the horn works. This introduces impedance variations which could result in peaks or dips in response. In effect, there can be a sort of acoustical short circuit, waves from the horn mouth cancelling (or reinforcing) those from the front of the driver. To overcome these variations, each side of the speaker cone—where it works into the horn throat—is fitted with a small Helmholtz resonator (see the cutaway photo) tuned especially for this speaker-horn parameter. The resonator helps to smooth out the peaks and dips, and eliminate them as factors in the response. The resultant impedance curve shows a total variation of no more than 2 to 1, which is, obviously, much lower than that in conventional speaker systems. Such a low variation has a distinct advantage as the terminating load for an amplifier, since it makes less demand on the complex of damping, stability, recovery time, power reserves and response throughout the audible range. The HFS-2, consequently, can be driven by good amplifiers of any power rating.

The Hegeman Professional

The Eico HFS-2 was conceived originally as integrated speaker–enclosure system of relatively small size, to work well in the average living room. Additionally, two—for stereo—should not crowd out the other furniture or the occupants, yet it is not dwarfed performance-wise in larger rooms. Highly satisfactory stereo demonstrations, using two HFS-2's, have been given in halls seating about 750.

The HFS-2 should be judged by the same musical criteria that have been applied to its big-brother prototype, the Hegeman Professional. This speaker, available from Hegeman Laboratories only on special order, has been since its development four years ago, the trial balloon in which have been tested the various ideas and design parameters used in the HFS-2. In laboratory, as well as in practical applications in studios and many homes, these ideas and designs have proven themselves.

The Pro uses two 8½-inch bass drivers working into a huge, double-section, slot-loaded conical horn. The combined piston action of these drivers provides fundamental bass below 20 cycles. An electrical crossover at 200 cycles furnishes mid-range frequencies to two independent drivers; a second crossover at 8,000 cycles feeds highs to a tweeter. The speaker elements resemble physically those used in the HFS-2. END

"It's still not right! I used to knock that picture off the wall at only half volume!"

new STEREO and MONAURAL RECORDS and TAPES

Reviewed by
Chester Santon
Station WQXR
New York City

STEREOPHONIC records are now worthy of review on top-grade equipment. This major breakthrough in the development of the stereo disc was touched upon last month with the mention of London's stereo demonstration record, PS-100. This pace-setting disc appeared during the first week in June. It is, in my opinion, the first commercial 45/45 product to approach the sound of the lacquer stereo record I heard last December on laboratory playback equipment. Subsequent first releases by other major record firms reviewed this month indicate progress but fail to match the presence, output level and quiet surface of the London recording. Reviewing these records by means of a belt-driven turntable and a moving-coil stereo cartridge, the full impact of the drastic change that has occurred in the stereo disc is clearly evident. Incidentally, for best results, I still use a monaural cartridge on my monaural records. When feeding the content of a monaural record to both channels, the 1-mil monaural stylus has a better signal-to-noise ratio than does the 0.7-mil stereo stylus.

A Journey Into Stereo Sound
London FFSS Stereo Disc PS-100

This leading stereo record to date does much to explain London's absence from the stereo tape catalog. While many American firms were issuing stereo on tape, London steadfastly maintained its belief in the disc as the principal medium for stereo. In addition to excerpts from current classical and popular recordings, this sampling includes highly realistic sounds of racing cars, trains and the changing of the guard in the Tower of London. The lows, rivaling some of the better efforts on tape, are more clearly defined than those on previous stereo records. The highs above 8,000 cycles provide a stereo effect of greater depth than that found on most stereo tapes. An outstanding demonstration item is the Ansermet rehearsal of Stravinsky's *Rite of Spring*. Having heard advance copies of forthcoming complete London FFSS (Full-Frequency Stereophonic Sound) releases, I am satisfied that the quiet surface and wide frequency range of this surprising record are not an isolated accident.

The Stereo Disc
Capitol SWAL-9032

Capitol's introduction to stereo on records effectively copes with such sounds as New Year's Eve in Times Square, a Diesel locomotive, ferry boat and subway train. Convincing evidence of a uniform spread of sound is found in the bowling-alley sequence with the ball rolling from one speaker to the other with unchanging intensity of sound. On the last band of side 1, castanets are heard as a central pinpoint of sound for channel balancing. On the other side of the record, there are exhilarating stereo samples of the Roger Wagner Chorale, the Pittsburgh and Hollywood Bowl Symphony Orchestras, Fred Waring and other Capitol stars. This record and the two stereo discs that follow are recorded at a level slightly lower than that of the London stereo record. As a result, surface noise is occasionally apparent. Other advance pressings of the initial Capitol stereo record release include *The Young Person's Guide to the Orchestra* and the first American recording of the brand new *Symphony No. 11* by Shostakovitch. I am reserving judgment on the matter of noise level in the soft passages of these classical releases until I have a chance to hear the regular pressings.

Deutschmeister on Parade
Julius Herrmann conducting Deutschmeister Band
Westminster Stereo Record WST-15007

The first Westminster record to reach me revives acquaintance with the unusual talents of the Deutschmeisters, already heard by many on monaural disc and stereo tape. The stereo effect here is much the same as that on the tape with the frequency range virtually equal to that of the monaural disc. Informal, carefree artistry such as this scarcely calls for expensive preservation on stereo tape when such sound is available on stereo disc.

Stereovox Sampler
Vox VST-1

$2.98 will let you know what Vox is doing in its first stereo records. At the moment, on the basis of this test pressing, they are trailing behind the labels mentioned above. This disc's sound effects—a sports car race, crowd noises and a New York City Civil Defense alert—are lacking in the presence that makes stereo exciting. Most of the music, performed by the Bamberg Symphony Orchestra, though enhanced by the second channel does not measure up to Vox' generally excellent monaural standard. In the case of symphonic music on stereo discs, it's still early in the game. Other major firms have scheduled their first stereo releases for late in August.

Music for Heavenly Bodies
Paul Tanner, Electro-Theremin
Andre Montero and his orchestra
Stereo Omegatape ST-3016
(7-inch; playing time, 43 min. $14.95)

Related to the Theremin family, the electronic instrument used in this tape represents the experiments of two Hollywood technicians. Unlike the regular Theremin where the player's hands move in the air without touching the instrument, the variable oscillator of this Electro-Theremin creates sound as the player operates a slide. It is the brain child of Paul Tanner, a trombonist formerly with Glenn Miller's orchestra. The audio range of the Electro-Theremin is stated to be from zero to over 20,000 cycles. Mixed with the conventional instruments, it should look more interesting on a scope than it sounds to the ear. The novelty of the arrangements hardly merits a tape of this length and price.

Zounds What Sounds!
Stereo Omegatape ST-2021
(7-inch; playing time, 22 min. $11.95)

This is a slow-starting entry from the stables of Robert Oakes Jordon and Jim Cunningham, the team responsible for many of the stereo sound effects found on demo tapes these days. The second half of this tape is more interesting than the first. The carillon at the University of Chicago and a parade at a Shriner's convention are given adequately realistic frequency response. The reel hits its stride in the last two items. In the *Tic Toc Fugue*, the ticking of a pocket watch is superimposed on its own sound that has been slowed down eight times. It is claimed that some of the components go down to 8 cycles. The tape comes to a climax with a Midwestern thunderstorm that is a corker. Bring up the gain to discover what may be the most violent transients in captivity today.

HANDEL: *The Messiah* (Excerpts, Vol. 2)
Thompson Stone conducting soloists, chorus of Handel and Haydn Society of Boston, Zimbler Sinfonietta
Boston Stereo Tape BO-10F
(7-inch; playing time, 30 min. $11.95)

Whenever mixed forces on a grand scale are employed by a composer, stereo is the preferred recording medium. These nine excerpts from *The Messiah*, parts of a performance issued in 1955 by Unicorn Records, underline stereo's usefulness in separating and clarifying the individual complexities of the orchestra, organ, chorus and soloists. The important bass frequencies that carry the weight of this music are fully captured here. Another tape bonus is the absence of annoying peaks in the reproduction of the soprano voice.

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

The Instruments of the Orchestra
Vanguard VRS-1017/18

This two-record album features the first-desk men of a symphony orchestra demonstrating the range and special characteristics of their musical instruments. The basic idea underlying the album is not a new one but the discs deserve wide circulation for several reasons. The sound is excellent, clean and very flat in response, and superior to other recordings of this type. The more detailed exploration and illustration of the various techniques possible with each instrument will add to the listener's enjoyment of the realistic recordings appearing today. So thorough is the coverage that in the string section alone 50 examples are offered, 21 of which are devoted to the violin.

Modern Jazz Concert
Orchestra conducted by Gunther Schuller and George Russell
Columbia WL-127

One of the more subtle challenges that can confront a clean-sounding system is ultra modern jazz of unlimited horizons. The six new compositions on this record were commissioned by the 1957 Brandeis University Festival of the Arts. Based on musical forms used in past centuries, they include some of the most advanced and rare tonal experiences available today. Not for the newcomer in jazz or audio.

STRAVINSKY: *The Rite of Spring*
Igor Markevitch conducting Philharmonia Orchestra
Angel 35549

The haunting first notes of the bassoon tell us that the typical closeup studio miking generally used by Angel for the Philharmonia Orchestra is being employed. Every formerly hidden crevice in the instrumental fabric is sought out by these mikes. The sound of tympani and bass drum, so prominent in this score, is softer in contour at this distance yet no less satisfying in profound lows. Good pacing by Markevitch.

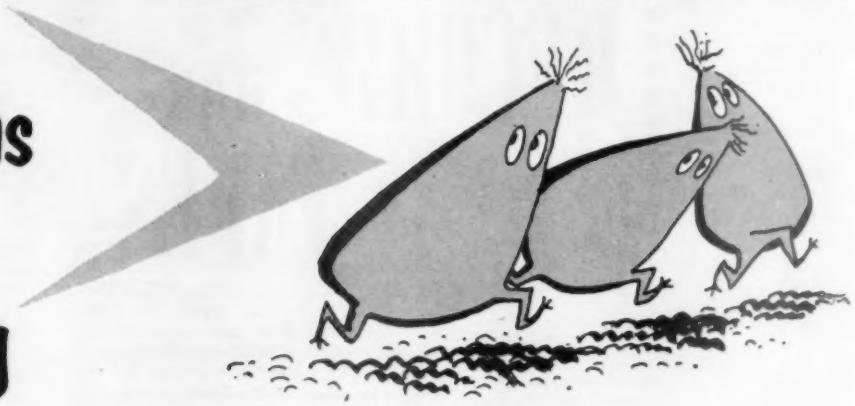
Ella Fitzgerald Sings the Duke Ellington Songbook
Duke Ellington and orchestra
Verve MGV 4010-4

This four-record deluxe album provides an ideal point of entry for the new audience now taking an interest in jazz. We can understand why Ella Fitzgerald is one of the most highly admired jazz vocalists of the day because she sings with infinite understanding the Ellington classics of the past 30 years. Ella and various combinations of the Ellington band are recorded in remarkable closeups. The liveness of the acoustics and the bouyancy of her singing go well together. The album is split in to Vols. I and II, available separately. Fitzgerald-Ellington fans have a wealth of popular and jazz favorites from which to choose. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14th St., New York 11, N.Y.*

Chasing the Gremlins out of Kit Building

Kits are easy to build, if you avoid wandering away from the instruction sheet. Some of the troubles you may encounter and what can be done to prevent them are discussed



By IRVING BECKER*

KIT building is constantly growing in popularity. Not only is it a way of saving money while acquiring high-fidelity components, amateur radio equipment and test instruments, but to many it is an end in itself. Its relaxing, therapeutic value in the evening or on weekends is not to be denied.

On the other hand, a completed kit that fails to work is frustrating. Therefore, manufacturers concentrate on designing a physical layout and carefully organized step-by-step instructions which will enable a novice to assemble the kit successfully *if he adheres to instructions.* Nevertheless, a small percentage of kit builders fall short of success. For these, the responsible manufacturer offers a repair service at a reasonable fee, assuring the customer that his instrument will be repaired and aligned. However, both the manufacturer and the customer would be happier if the demand for such service could be reduced.

With this in mind, here are a description of how we at Arkay seek to maximize the constructor's chance of success and some tips to the kit-building public on chasing the gremlins out of kit building. (These gremlins are usually found lurking in dark corners of the chassis.)

I feel that failures would drop very close to zero if the purchaser followed instructions to the letter. Possibly some of those who have built kits may have a different view. If this article stirs such individuals to voice their opinions as to how kits could be improved, their thoughts should be of value to kit manufacturers and ultimately to future kit builders.

In designing a kit, every attempt is made to make it foolproof. The first units are assembled by persons *without* previous kit experience, electronic knowledge, soldering ability or special mechanical aptitude. The results of these trials are used to rework the kit and the assembly instructions until it is proven that the instructions are easy to follow and if followed will result in equipment that operates satisfactorily.

If the design and instructions are eliminated as sources of trouble, the only other cause for failure attributable to the manufacturer is a faulty part—for example, an off-value resistor or a shorted capacitor. To minimize such failures, parts are purchased from reliable sources and the quality of incoming supplies is checked on a sampling basis. The bulk of the returns, under 1% of sales, are due to a mistake the builder has made. Of course, we would be happier if the percentage of returns were even smaller, and I feel this could be achieved by proper care on the constructor's part.

If the kit builder is successful, he is encouraged to go on to other kits, and so are his friends. Failure has the opposite effect. To would-be builders who have been deterred by the possibility or experience of failure, the following suggestions on chasing gremlins out of kits should greatly increase their courage and chances of success.

The soldering problem

Improper soldering is the greatest source of trouble, accounting for perhaps 80 to 90% of all returns. Soldering is an art but, so far as electronic kit building is concerned, it can be adequately mastered in a short time. Here are a few pointers:

A soldered connection should appear bright and smooth, never dull and rough. The latter indicates a poor connection, known as a cold solder joint, and is usually caused by insufficient heat or moving the joint while cooling. The result may be an intermittent electrical connection, no electrical connection at all or one with high resistance.

A good brand of rosin-core solder should be used. *Acid-core solder is taboo for electronic equipment.* A 60-40 solder (60% tin, 40% lead) is preferred and, though it may cost a little more, it is definitely a worth-while investment. This solder melts at a lower temperature, adheres better and generally gives greater assurance of a good electical connection than 50-50 or 40-60 solders.

The soldering iron should be clean and well tinned—its tip covered with bright-looking solder. When dirty, the tip should be cleaned with a fine file and retinned.

The lug or other point to which a part, such as a resistor or capacitor, is being soldered should be hot enough to melt the solder. For example, heat the lug with your iron and apply solder to the lug. The solder will not melt until the lug is hot, thus insuring a good connection.

Avoid excess solder. If too much flows onto a connection, remove the excess with the tip of the iron or a screwdriver. However, enough solder to fill completely the space within a lug should be used.

Too little heat is a frequent source of difficulty. In soldering one or two leads to a lug, a 25–50-watt iron is usually sufficient. But if the lug is connected to the chassis, which quickly drains the heat from the iron, 100 to 150 watts is desirable. Therefore, it may be necessary to switch from a low-wattage to a high-wattage iron while assembling a kit. A high-wattage iron is also necessary when soldering a large number of parts to one lug. In these situations you may get away with an iron of about 50 watts if you let it heat for a while and then solder very quickly, before the heat drops. Remember to let it heat again before going to the next connection or you risk a cold solder joint.

Too much heat can also cause problems. When using an iron that produces much more heat than called for, work quickly. A high-wattage iron applied too long to the lug of an if transformer can burn out the transformer wire where it joins the lug. When soldering a shielded cable, ex-

*President, Arkay, Inc.

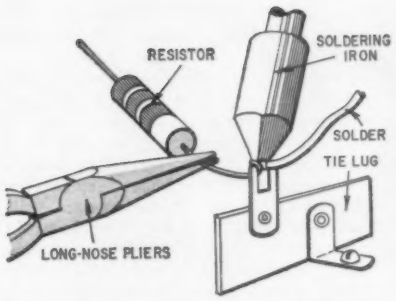


Fig. 1—Using long-nose pliers for a heat sink will save resistors and capacitors.

cessive heat can melt the insulation around the inner wire, causing a short between the inner and outer conductors. Excessive heat can cause resistors to become noisy and change in value. To be safe, a heat sink should be used when working with components which may be damaged by heat. One method of doing this is to clasp the component's lead with long-nose pliers at a point between the soldering iron and the body of the resistor (Fig. 1). However, this will sometimes call for three hands. Instead of pliers, you can use an alligator clip to which a piece of heavy wire has been soldered, as in Fig. 2. This device, of course, is self-clamping.

Once the soldered connection has been made, do not disturb it until it has cooled and hardened. Otherwise a cold solder joint, dull gray in appearance, will result. If this happens, the solder should be remelted and allowed to harden again.

Lead dress

Correct lead dress is not a matter of making the underside of the chassis attractive but is a means of getting the circuit to operate properly, especially in a tuner or high-gain amplifier.

Some of the kits returned for repairs contain excessively long leads, a veritable hornet's nest of wiring. Where short leads are essential to correct operation, the instructions specify the shortest lead possible (see Fig. 3). Still, some constructors depart from instructions and pictorial diagrams by making very pretty right-angle wiring where it isn't called for. This may look good, but often doesn't work right. It adds inductance, which can seriously change the resonant frequency of a circuit in an FM tuner. Lead inductance can also cause hum or signal pickup, the latter possibly resulting in positive feedback and oscillation.

Leads should be routed according to instructions. If the manual says to dress the lead tight against the chassis, there is no excuse for doing otherwise. Yet kits are returned with a network of wires hovering in the air, acting like little antennas to pick up hum and other troubles.

A little inattention to the instructions for use of insulated sleeving (spaghetti) can cause much trouble. Omission of spaghetti can let one lead contact another or short to ground. The result may not only be an unworkable kit, but is more likely to be destruction of various parts such as resistors, tubes and transformers.

Haste makes waste

Kit instructions are spelled out in a large number of easy steps so that the beginner can put together a complete instrument. This detailed procedure does not appreciably increase assembly time. Regardless of how the instructions are presented, the same number of parts would have to be mounted and the same number of connections made. Yet in a number of returned kits, there are obvious signs of impatience with the deliberate pace of the instructions. The builder has gone ahead on his own, soldering this part or that before the manual told him to do so. And mistakes are the usual consequence.

This is even more likely to happen if the builder is an engineer, a physicist or some other individual with claim to an advanced knowledge of electronics. On the other hand, the gentleman who

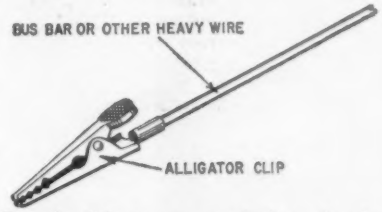


Fig. 2—Where you need three hands, this heat sink with its own fingers is a valuable aid.

drives a truck and has learned to obey road signs is apt to produce a careful, neat job, showing all the indications of scrupulous conformity to instructions. True, the latter's kit might not have been returned had he not run into some kind of difficulty, but typically this difficulty is of a simple sort, easily detected and repaired at minimum cost. Or there may not even have been an error. For example, a tuner may have been returned only for alignment. However, the impatience of the electronics expert with the assembly procedure may lead to serious mistakes.

Arkay's service technicians have become adept at reading the kit-builder's character by looking at the wiring of his kit. Sometimes they find very neat work at the outset of the project, moderately neat work midway and sloppy work thereafter—all the signs of the person who soon grows impatient and bored.

Some constructors don't even finish the job. Equipment is returned with parts unmounted, dials unstrung, etc. There is no need to complete a kit in one or two nights or even one or two weeks. There is no race and no prize for the fastest building time. There is no more purpose in dashing through a kit than through a fine book. The pace of the work should be adapted to the builder's temperament and spare time. Rushing to complete a kit can lead only to errors and the expense of having them corrected. There is no problem in resuming interrupted work on a kit, because the instructions constitute a check list, and you simply start again with the step after the last check mark.

A measure that may save time overall, although it adds to the time of each step, is using an ohmmeter to check connections during construction. Where a lead goes directly from one point to another, the ohmmeter should read zero resistance between these points. If a resistor is connected between two points, the meter should read the resistor value. If a capacitor goes between two points, the meter should read infinite or very high resistance, unless there is also a resistor between the same points.

Transistor equipment

Transistors are finding their way into kits as well as ready-made equipment. Usually the manufacturer provides a socket to hold the transistor. The constructor should not put the transistor into the socket until all soldering has been completed.

If the temperature in the immediate vicinity of the transistor goes above 120°F, it may be damaged. Although the equipment will be designed to prevent this much heat near the transistor, the situation is not entirely under the kit manufacturer's control, because the constructor may place the kit in a place where ventilation is poor, causing heat to build up to an unusual degree. Be extra careful and make sure there is plenty of air space around any kind of transistor equipment. If the manufacturer suggests adding a heat sink, do so, following his instructions.

In case of trouble

If the instrument fails to operate properly after assembly and alignment, review the work, step by step. The mistakes you will ordinarily find are cold

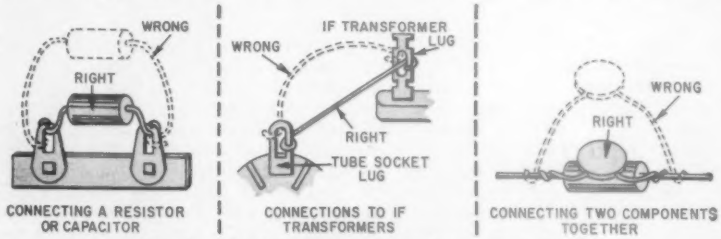
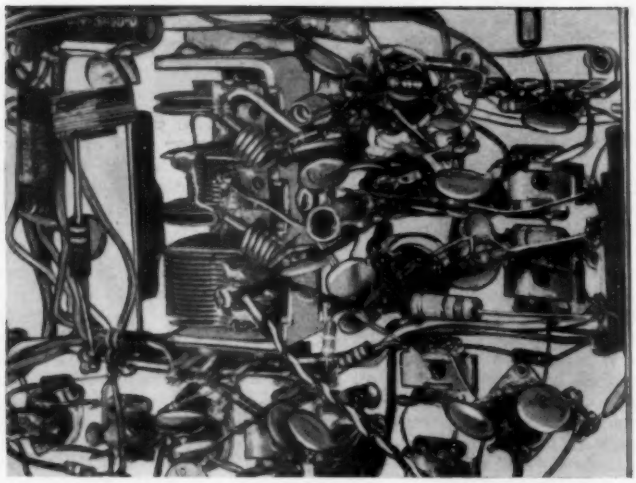
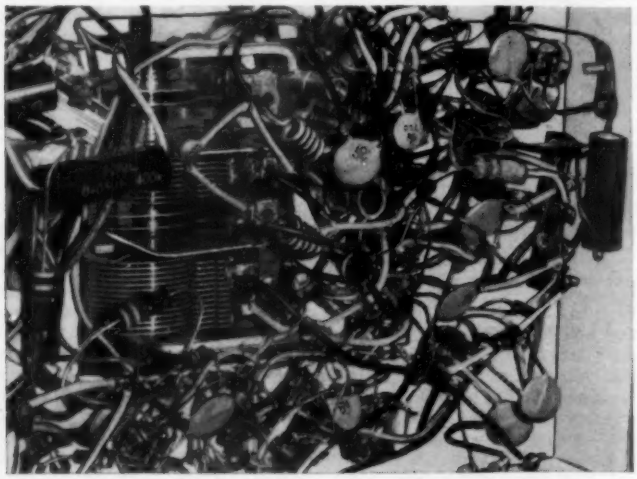


Fig. 3—Short leads are sometimes vital. Here are some ways of getting the desired results.



The right and wrong ways of wiring a kit. (Top) Following the step-by-step instructions gives you a kit that is neat and operates properly. (Bottom) A prime example of how not to wire a kit. Parts are jammed in every which way and the result is a unit that does not work as it should.



solder joints, unsoldered connections, resistors or capacitors interchanged, parts connected to the wrong points, parts omitted, transformer color-coded leads mixed up.

It may turn out that a power transformer lead fails to make an electrical connection because the enamel has not been scraped off the lead. Sometimes a builder will mount a tube socket from above the chassis instead of inserting the socket from below. Mounting from above shorts the socket lugs against the chassis. An occasional misadventure is that a kit builder may construct the equipment inside out. That is, everything that should have been mounted on one side of the chassis is mounted on the other side. This is more apt to occur in "flat" equipment, where the chassis is in a vertical rather than horizontal plane. Here the kit builder may make the mistake of mounting on the front of the chassis the components that are supposed to be on the back, and vice versa.

We all have blind spots, and one may occur in building a kit. It is typical that in reviewing one's work for the cause of a malfunction, the same blind spot will recur again and again. If the constructor can get a friend to check the work on the kit, it is quite possible that the friend will find in a matter of minutes an error that the constructor might not find in hours. Some individuals have a false pride that keeps them from calling for assistance. In the case of the engineer or physicist, this is apt to be particularly true. They simply don't like to admit being stumped by what they consider an elementary piece of electronic equipment.

Voltage and resistance readings are usually supplied in the instructions, and, if you own or can borrow a vom or vtvm, you can check these readings at the designated points. When resistances or voltages differ appreciably from the rated values—more than 20% —there is strong probability of a mistake in wiring or of a defective component. If these differences are confined to just one part of the circuit, the mistake is very likely in that region, and a step-by-step check of your work in that area is called for.

If the constructor cannot track down the source of difficulty, he is naturally reluctant to pack his kit, mail it to the manufacturer and wait several weeks for its return. There is a strong temptation to bring it to a local service shop. However, this may be much more costly and less effective than returning it to the manufacturer. No slight is intended upon the abilities of the local technician. But he is accustomed to repairing equipment that was wired correctly originally and operated properly. The kit you bring in may be his first encounter with this instrument, and he may spend hours, at your expense, comparing your work with the circuit diagram until he finds the mistakes. On the other hand, the manufacturer's service technician is completely familiar with the kit and can generally spot the trouble in moments instead of hours.

Before you return a kit to the manufacturer, write him a letter stating your difficulties. For your sake as well as his, type the letter. Describe all the symptoms in orderly 1, 2, 3 fashion. If he cannot fathom the source of your problems, he will ask you to return the kit for servicing, at a moderate charge.

Because of careless packing on the kit builder's part, sometimes the greatest damage to the equipment occurs when he ships it back to the manufacturer. The kit should be placed in a carton a few inches bigger in each dimension than the kit, and this space should be filled in with crumpled or shredded newspaper. It's a good idea to save the original carton until the kit is finished. This box is ideal for returning the unit, should such a step become necessary. Railway Express, although more expensive than parcel post, gives best assurance of intact arrival. If you do ship by parcel post, take extra precautions in packing and mark the carton fragile.

The unnecessary return

While most returns are justified, a certain percentage could easily be avoided. Incredible as it may seem, some customers return an entire kit because one or two small parts, such as a couple of resistors, are missing. If such parts have inadvertently been omitted, the manufacturer will take your word for it and send them to you without charge.

Sometimes a kit is returned in which everything has been correctly assembled, but the tubes are in the wrong sockets. Occasionally an AM–FM tuner is returned as inoperative because the customer failed to connect an FM antenna in the mistaken belief that the AM antenna (ferrite loopstick or wire loop) also serves for FM. Sometimes a kit is returned with no signs of anything wrong. We can only guess that the customer failed to connect the power plug to the house line or that a tube may not have been inserted securely into its socket. END

HOW to SERVICE TRANSISTOR RADIOS

Finding troubles in transistor radios is easy, if you know what to expect

By H. V. STEWART *
and C. W. LIGHTFOOT *

THE ever-increasing popularity and production of all-transistor radios has opened a new field for the service-technician. This new field, although limited in volume because of the near-infinite life of the transistor, requires new techniques and basic skills. Just as a fine watch will last a lifetime if it is cared for reasonably, so will an all-transistor radio. The amount of servicing required by a fine watch is seldom more than cleaning and adjustment unless it has been mistreated. The all-transistor radio is proving to be very much the same. The transistor has shown it has very long life. Failure is definitely the exception rather than the rule.

99.9% of all repairs . . .

The troubles experienced in the field with the all-transistor radio fall into three basic areas which cover 99.9% of the complaints. Most common of all are difficulties associated with the battery in some way. These may take several forms—from a dead battery to one installed improperly (usually inserted backward).

Intermittent contacts are common, particularly when cells are left in the radio until they leak, corroding the contacts. The unusually long battery life in transistor radios contributes to these difficulties. Owners tend to lose track of the length of time batteries have been in service, so they are left in the radio after they should have been replaced. As a general rule, when the voltage across the battery supply, with the set on, drops below 75% of the rated voltage, replace the batteries.

The electrolytic capacitors used in transistor radios are the second cause for service. Miniature packages and circuits require low-voltage high-capacitance dry electrolytics. Decreasing in capacitance with age, these units are a common cause of motorboating, oscillation, no output, reduced output and distortion. Audio coupling capacitors (usually 2 to 5 μf) in older receivers have been known to drop to less than 0.5 μf, seriously impairing the receiver's output. Constant research and improvement of these components have lessened this complaint in later receivers. Low-voltage high-capacitance electrolytics can be damaged by reversing the supply of voltage polarity or applying some potential above their voltage rating.

Breaks in printed-circuit-board conductors, poor electrical connections and cold solder joints are the third major cause of service in the transistor receiver. Voltage and continuity measurements made while gently flexing the chassis or printed-circuit board will usually pinpoint the trouble.

Working on the printed circuit

Major breaks in printed - circuit boards require special tools, equipment and material to make a new board. This type of repair is best done by the manufacturer's service department. A single break in a printed lead can be repaired by soldering a short jumper of tinned copper wire across the break.

The techniques needed to repair printed-circuit transistor receivers do not differ from those used on printed-circuit vacuum-tube receivers. For instance, only enough heat to melt the solder quickly should be used. The 37.5-watt pencil type soldering iron is adequate for most circuit work. However, if a larger iron is needed to melt the solder quickly, it should be used, but only long enough to make a good solder connection.

Excessive heat will blister the printed-circuit board and raise the ribbon from its insulating base. Excessive heat applied directly or indirectly to transistor leads can permanently damage the transistor. When heat is applied directly to the transistor leads, heat-sink the leads with long-nose pliers.

Always be careful

Less than 1% of the transistors in radios require replacement under normal use. However, while servicing transistor radios the transistors can be destroyed or damaged by applying excessive or prolonged heat to their leads,

*Application engineers, Texas Instruments Inc.

Flexing the printed circuit board will reveal hairline cracks that can cause intermittent operation.

connecting an incorrect battery potential to the circuit, shorting elements by connecting meters and scopes in the circuit and by shorting elements with solder splashes.

If there is no indication of receiver failure due to battery strength, battery polarity, opens or shorts in the circuits, use your vtvm to evaluate the transistors. Using the ohmmeter section of a vtvm, the diodes in a good transistor (base to emitter and base to collector) will show a front-to-back ratio of 100 to 1 or more. Do not use a vtvm that uses more than 3 volts for measuring resistance or you may damage the transistor.

Voltage and current checks

Voltage measurements in the transistor receiver should be made with respect to the transistor's emitter. For p-n-p transistors the base should be negative with respect to the emitter by approximately 0.2 volt. The collector will be negative in an amount determined by circuit design. For n-p-n transistors, the base will be positive with respect to the emitter by about 0.2 volt while the collector will be positive by an amount determined by circuit design.

Current values in a transistor circuit can be determined by measuring the voltage drop across the emitter resistor and calculating the current, using Ohm's law.

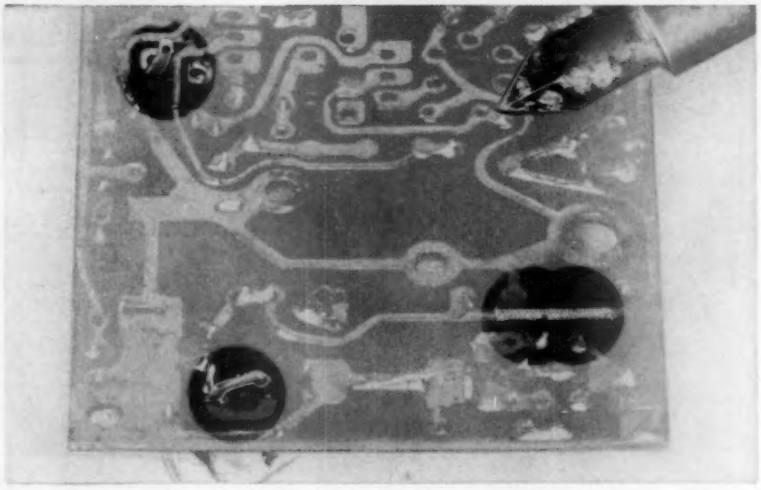
The initial current should be measured with the volume control fully advanced, the tuning gang at minimum capacitance and no signal applied.

The current value in each stage will vary even with transistors of the same type, so only average values can be stated.

Fig. 1-a is a typical transistor converter stage. Voltage E1 divided by the emitter resistance will be the emitter current in this stage. This current will average 0.5 ma (0.4 to 0.6 ma)..In a normally operating converter stage, emitter current will show a 10% increase at the high end of the band over the value at the low end. This change should be linear and smooth. Any erratic change indicates oscillator malfunctioning. E2 should read 0.2 volt positive with respect to the emitter.

When soldering a new transistor in place, use long-nose pliers between transistor and board as a heat sink.

Lifted foil on printed-circuit board (spotted on left) was caused by excessive heat due to too-big soldering iron (upper right). At lower right a piece of braided wire replaces damaged section of printed wiring.



Normally, the base is negative with respect to the emitter but the positive reading indicates the oscillator portion of the stage is functioning.

Fig. 1-b shows the if and detector stages of a typical transistor receiver. E3 divided by the emitter resistance will be the emitter current in the first if amplifier and should average 0.5 ma at zero signal input. When signal is applied to the receiver, this current should decrease in proportion to the signal applied until cutoff occurs at about 50 mv per meter. If the current in this stage increases with signal level, the detector diode is installed backward. E4 will be 0.20 volt with the base negative in respect to the emitter.

E5 divided by the emitter resistance will be the emitter current in the second if amplifier and should average 1.0 ma (0.75 to 1.25 ma). This current should remain constant with changes in signal level. E6 will be 0.20 volt with the base negative with respect to the emitter.

Fig. 1-c is the audio driver stage of a typical transistor receiver. Emitter current, found by dividing E7 by the emitter resistance, should average 2.0 ma. E8 should be approximately 0.20 volt with the base negative in respect to the emitter.

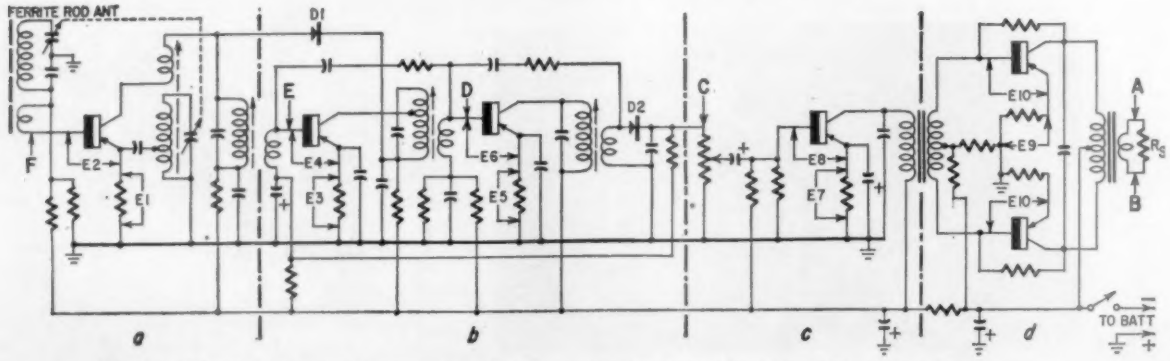


Fig. 1—Circuit of a typical transistor radio: a—converter stage; b—if amplifier and detector stages; c—audio driver stage; d—audio output stage.

Fig. 1-d is a class-B audio output stage with separate emitter resistors. (In some receivers a single emitter resistor may be used.) E9 divided by the emitter resistance will be the emitter current in this stage. This value will be low at zero signal input and should increase with signal level. These values vary, depending upon the battery voltage used. E10 should read approximately 0.2 volt with the base negative with respect to the emitter.

Most manufacturers specify the power level of undistorted and maximum output of their receivers. Undistorted power output is that level at which clipping on upper and lower peaks begins to occur. Maximum power output is square-wave power.

To make these measurements, disconnect the speaker and measure the dc resistance of the voice coil. This value will be R_s as shown on the diagram. Connect the voice coil leads of the output transformer across a resistor with the value of R_s.

Connect an oscilliscope and a vtvm across R_s. These points are shown as **A** and **B**. Connect the output of an audio oscillator through a small electrolytic (2–10 μf) to point **C**. Apply a 400-cycle signal and read the ac voltage at the point of clipping and at maximum output. The power output can be found by Ohm's law.

Signal substitution in the transistor receiver is much the same as in the vacuum-tube set. The output of a standard AM signal generator is connected through a 100,000-ohm resistor to point **D**. A modulated if signal is applied with only sufficient amplitude to produce an output power less than the clipping level. At this time the output if transformer can be aligned, if necessary. When this signal is applied in the same manner to point **E**, a definite gain will be observed. At this point the interstage if transformer can be aligned if necessary. The signal is then applied, in the same manner, to point **F**. Again, a definite gain will be observed. At this time the input if transformer can be aligned, if necessary. Finally, signals should be radiated into the antenna through a loop and the receiver aligned as recommended by the manufacturer for optimum performance. If anywhere along the line, going back a stage does not give increased gain, the stage must be bad.

When replacing parts . . .

Use an exact replacement part if any component must be changed. This is especially true with coils and transformers. These match certain transistor parameters to the circuit used. No universal replacements for these parts are available.

By using reasonable care and following the precautions outlined here, servicing transistor receivers should be no more difficult than working with tube circuits. If any doubt exists, most set manufacturers will be happy to supply information on their circuits. END

. . . and Now, the CRYSTAL SET!

AT last it's here! One of the most incredible inventions of our century! For the first time ever, a *lifetime pocket-size portable radio* that uses no batteries, no tubes, no transistors . . . in other words, A MIRACLE RADIO THAT NEVER WEARS OUT—AND PLAYS FOREVER!"

Thus begins a full-page advertisement in a New York newspaper, revealing the startling facts about an amazing new product of the atomic age (at $4.95 plus postage).

What is it? Why, the lowly crystal radio of the early 1920's—all decked out in modern dress and atomic-age press-agentry.

Nowhere does the ad use the word "crystal"—and veterans of the cat's-whisker will be interested in this description of the scientific breakthrough which now makes possible a tubeless, batteryless radio:

"Recently while working on a military problem, scientists developed a new type of self-powered rectifier called a GERMANIUM DIODE . . . the same miracle invention now being used on all radar and sonar equipment. This new invention actually generates its own power by drawing electric waves RIGHT OUT OF THE AIR just like a magnet, and converts those waves into power-producing electricity!"

Here's a further explanation, which you'll never find in any radio course:

"It is this amazing electronic discovery that finally makes it possible for you as a civilian to own a lifetime pocket radio. . . . Because instead of bulking up a radio with all sorts of expensive parts and tubes, scientists have actually condensed an entire radio powerplant into this one single part that is no bigger than a dime, that generates more power than 1,000 batteries and that never wears out no matter how much you use it. Because, incredible as it may seem, each time you use it, it draws in more electric power from the air. It then feeds itself a new 'electrical meal' and stays just as powerful as when it was brand new!"

Not only will this hungry radio gobble electrons from the air in your own home, but for the same sawbuck the advertiser says he'll throw in "two bonus features—features you'd ordinarily expect to find only on extremely expensive hi-fi sets!" These are a "ferrite loop antenna" and a "direct circuit personal earphone speaker" (no loudspeakers on crystal sets, of course).

This miracle radio, says the ad, "pulls in programs as sharp and clear as though you were sitting in the broadcasting studio," and it's "so powerful it picks up broadcasts from as far as 10 cities away" (North Dakota editors please note).

But before you throw away your old, out-moded tube or transistor radios, and substitute these glamorized, slenderized crystal sets, it's a good idea to try one.

They work pretty good, like a crystal set should.

Given enough antenna, the ones we've tried will bring in two or three stations in the heart of the city. Which stations they are, you can't tell until you hear the identification (no calibrated dial, of course).

As toys or novelties, the "new" crystal sets are lots of fun. Using a germanium diode as a detector and with inductance or capacitance tuning, they're generally housed in attractive plastic cases, usually are Japan-made. Prices range from $2.95 to about $5.

(We didn't have an opportunity to test the crystal set advertised so flamboyantly. On the basis of consumers' complaints, the New York State Attorney General obtained a temporary injunction barring the sponsors of the ad from doing business while the state seeks to dissolve the company on charges of fraud).

These new "miracle" diode radios are flooding the country. So if the whoop-de-do about the "radio that lasts forever" hasn't yet reached your area, brace yourself and prepare for the greatest scientific breakthrough since the invention of smoke signals.

This is truly the age of electronic miracles: From wireless to radio broadcasting, to TV, to hi fi, and now—

The crystal set! END

"Now this model not only awakens you, makes the toast and coffee, but also sees to it that you get out of bed!"

Looking in on LONDON

TV dx reception across the Atlantic is possible with the right equipment. Here's how to convert an old receiver to pick up those European stations

By HARTLAND B. SMITH, W8VVD

DURING my 18 years as a licensed radio amateur I have had many exciting dx contacts. I can honestly say that none of these gave me quite as much of a thrill as when I first saw an identifiable transmission direct from London on the screen of my own TV set. The realization that I was watching an event which was taking place almost 4,000 miles away, across the Atlantic Ocean, was truly a breath-taking experience.

Almost as remarkable was the ease with which I got this dx TV reception. My relatively simple equipment included a slightly modified ancient 10-inch television receiver, a pre-world War II FM tuner and a couple of indoor antennas. With this gear I picked up many telecasts from Britain during December, 1957, and January, 1958. With a little luck, patience and ingenuity, the average electronic experimenter should be able to duplicate or better my results this coming winter. The photographs are typical of the kind of reception I got. All broadcasts came from London.

TV dxing is not recommended as an avocation for beginners. However, if you know your way around a TV chassis, are acquainted with high-frequency receiving techniques and have successfully constructed a few pieces of electronic gear, you are qualified to try your hand at tuning in on London. The material which follows will give you some idea of the problems which may be encountered while searching for signals from "across the pond."

This kind of long-distance reception may appear somewhat fantastic to those acquainted with the 50–150 mile range of the average US TV station. Nevertheless, during the past two winters, there were a number of days when TV transmissions arriving in the midwest from Europe were exceptionally strong. There is every indication that European TV signals of equal excellent intensity will again be encountered next winter.

TABLE I—EUROPEAN TV STATIONS MOST LIKELY TO BE RECEIVED IN US*

Location	Video Freq (mc)	Video Power (kw)	Audio Freq (mc)	Audio Power (kw)
Belfast, Northern Ireland	45.00	12	41.50*	3
London, England	45.00	200	41.50*	50
Caen, France	52.40	80	41.25*	20

A list of all foreign FM and TV stations may be obtained from Superintendent of Documents, Government Printing Office, Washington 25, D. C. Ask for *Broadcasting Stations of the World, Part IV* and enclose 75¢ in coins.
*Sound is AM.

How and when

We are all accustomed to the world-wide transmission of radio signals on the high-frequency bands extending to approximately 30 mc. Long-range reception on these frequencies is possible because the signal from the transmitter shoots off into space and is reflected to earth by the ionosphere. Depending upon the angle at which the radio wave hits the reflecting ionospheric layer and on the height of this layer, the signal returns to earth a few miles from the transmitter or thousands of miles away. At one time, it was believed that signals above about 30 mc always penetrated the ionosphere and never were reflected. However, in recent years the spectrum above 30 mc has become loaded with amateur and commercial stations and we have discovered that there are occasions when even signals above 50 mc are reflected by the ionosphere and come back to earth a great distance from the transmitter.

The period of long-range transmission on these frequencies occurs only during years of maximum sunspot activity. Since there were more sunspots in 1957 than at any other time in recorded history, world-wide propagation of signals on frequencies near 50 mc became commonplace. The number of sunspots will decrease during 1958, probably to a level approaching that of 1956. But there were a number of days in 1956 when 50-mc signals were heard around the world, so there is every reason to believe that with proper equipment 45-mc television signals from London will again be receivable in the United States later this year.

European TV comes in best during the fall and early winter months. So, if you wish to attempt to pick up these signals, your equipment should be ready to go not later than the middle of October.

The most important piece of gear for use in hunting TV dx signals is an FM radio receiver which covers 40 to 50 mc. With one of these sets you can monitor this part of the spectrum to check on what stations are coming through, and you can listen in on the sound portions of any video programs which you succeed in viewing. I am lucky enough to own an old Meissner tuner that covers the 40–50-mc band formerly occupied by FM broadcast stations. This unit has picked up TV sound signals from London and Manchester, England; Caen, France and Berlin, East Germany. The raspy notes of the London and Berlin video carriers have also been successfully picked up.

A number of FM receivers that tune from 30 to 50 mc are presently being marketed. Among these are Monitoradio's model PR-31 Police Alarm, the Hallicrafters Civic Patrol type S-94 and the Gonset model 3155 vhf communications receiver. Although the French and English sound transmissions are amplitude-modulated, they can be received on FM equipment by tuning slightly off to one side of the signal.

TABLE II—COMPARISON OF WORLD'S TELEVISION SYSTEMS

	British	US	Int'l Radio Consultative Committee	Russian	French
Number of lines per picture	405	525	625	625	819
Video bandwidth (in mc)	3	4	5	6	10.4
Channel width (in mc)	5	6	7	8	14
Line frequency (horizontal) (in cycles per second)	10,125	15,750	15,625	15,625	20,475
Field frequency (vertical) (in cycles per second)	50	60	50	50	50
Picture frequency (cycles)	25	30	25	25	25
Sense of video modulation	Pos	Neg	Neg	Neg	Pos
Sound modulation	AM	FM	FM	FM	AM

The French sound comes through quite regularly on 41.25 mc, but the accompanying video at 52.4 mc is so high in the spectrum that there is little chance of receiving it except on extremely rare occasions this coming winter. The European video carriers most likely to be picked up in the US are those from London and Belfast. Since London has an effective radiated power of 200,000 watts, and Belfast 12,000 watts, it is easy to see why the London transmissions are the most consistent, and usually the strongest. Consequently, if you decide to try your hand at TV dxing, I suggest that you center your efforts in the direction of Britain. Table I lists the vital statistics of the dx stations you are most likely to encounter.

By studying Table II, you will note a number of differences between the British 405-line system and our own 525-line standard. The first important dissimilarity is in the spacing between the sound and video carriers. This disparity means that, if you want to hear the audio, along with the picture, you must have a separate sound receiver.

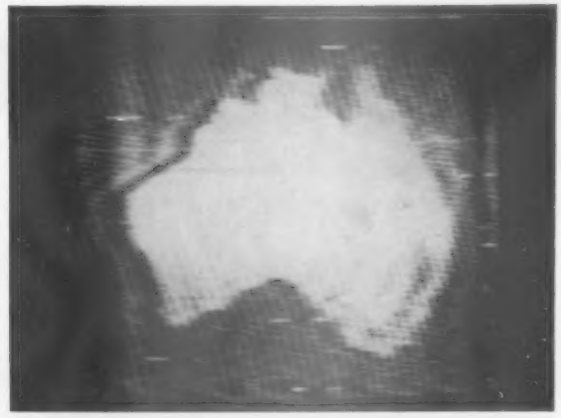
Modifying the sweep circuits

The horizontal frequencies of the two systems differ markedly. I doubt if any factory-built American TV set is equipped with a horizontal control that can shift the oscillator from the normal frequency of 15,750 cycles to the British frequency of 10,125. This means that you'll have to dig into your TV set a bit and make a few modifications. Two popular horizontal oscillator circuits are shown in Fig. 1. If your set uses a multivibrator (Fig. 1-a), you can add capacitance across the ringing coil to lower the frequency. In my receiver, I had to add a .01-μf capacitor at this point. As this change caused the oscillator to operate somewhat erratically, I also added a 470-$\mu\mu$f mica capacitor in parallel with the coupling capacitor between the multivibrator triodes.

An oscilloscope and a calibrated audio oscillator will help you set the horizontal oscillator to the required frequency. Tune the audio oscillator to 10,125 cycles. Connect its output to the scope's horizontal input. Then, connect the vertical amplifier of the scope between point A and ground. When the multivibrator is running at 10,125 cycles, the pattern on the scope will appear as a slightly warped circle. By trying different capacitances across the ringing coil and adjusting the slug in this coil, you should finally arrive at a point where the receiver's horizontal oscillator is working at the British standard.

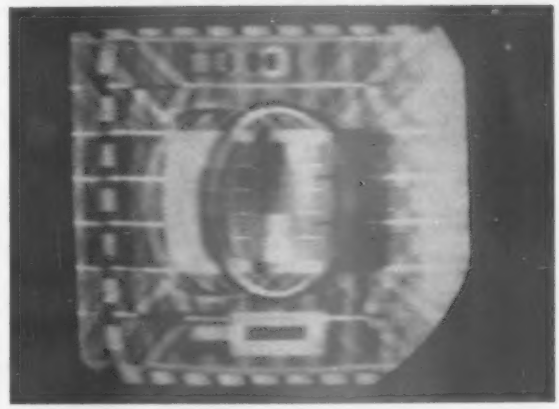
If your set has a blocking oscillator circuit (Fig. 1-b), a mica capacitor may be wired in parallel with the grid coupling capacitor to lower the horizontal frequency. A value somewhere between 200 and 500 $\mu\mu$f will probably do the job.

The 50-cycle British vertical frequency is close enough to the American standard of 60 cycles to let the vertical



Map of Australia. Received at 0930 hours, Jan. 14, 1958.

Violinist. Received at 1055 hours Dec. 29, 1957.



BBC test pattern. Note the multiple ghosts.

Woman discussing coughs and colds. Received at 0945 hours, Jan. 14, 1958.

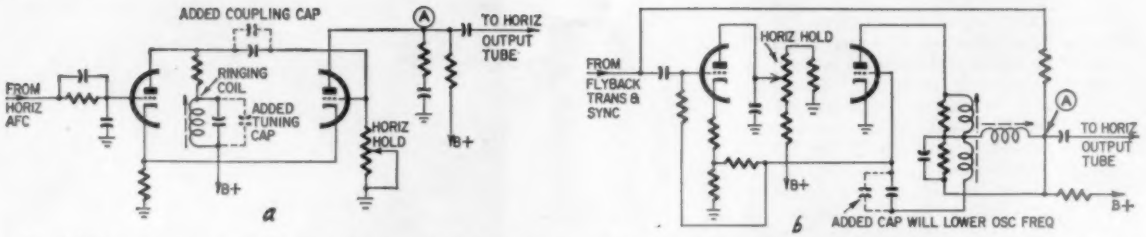


Fig. 1—Adding capacitors is the simple step that changes sweep frequencies to match European standards: a—horizontal multivibrator; b—blocking oscillator.

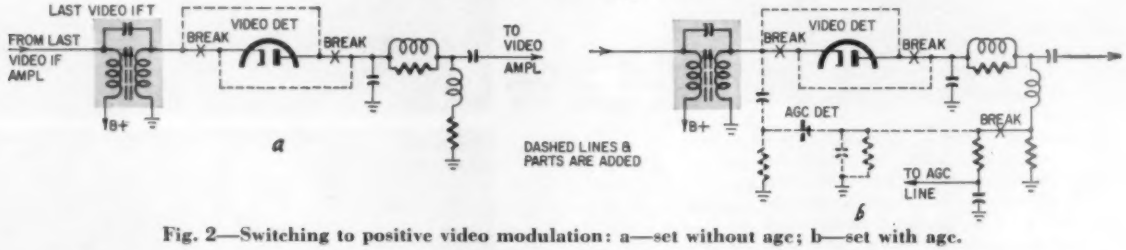


Fig. 2—Switching to positive video modulation: a—set without agc; b—set with agc.

hold control on your receiver take care of either system.

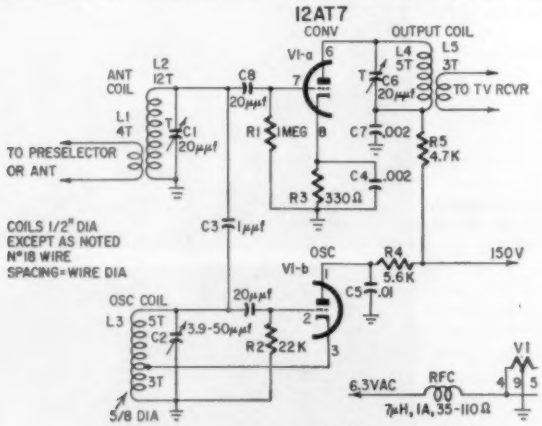
The American *sense* of video modulation is negative. This means that in this country, as the strength of the carrier increases, the picture gets blacker on the face of the picture tube. English TV stations use positive video modulation and the picture gets whiter as the strength of the video carrier increases. Because of its opposite polarity, the white part of a British picture will appear black on an American receiver. This results in a negative image when a BBC signal is fed to one of our unmodified domestic receivers.

Luckily, there is a very simple way out of this rather strange situation. All you have to do is to reverse the cathode and plate connections of the video detector as shown in Fig. 2-a. Fig. 2-b shows the hookup to use if your receiver derives agc voltage from the video detector. Typical constants for the agc network can be found by studying similar circuits used in sets made around 1951 and 1952. However, if your set has dc coupling between the detector and first video amplifier, it cannot be used without making extensive changes. This change is needed only to tune in British and French stations. Other European countries use the familiar *negative* video modulation.

Frequency conversion

The European stations you want to see operate on channels not covered by American TV receivers and frequency conversion must be used ahead of your set. The circuit shown in Fig. 3 is that of an old converter which I happened to have on hand. It was readily adapted to the 40–50-mc range by changing the coils. Since it lacked adequate sensitivity, I added a 6AG5 preselector (see Fig. 4).

Channel 5 (76–82 mc) is vacant in the Detroit area and was chosen as the output frequency of the converter. When tuned to the 45-mc English video frequency, the converter oscillator can be operated either on 33 or 123 mc to produce an output frequency in the middle of channel 5. Because of the vestigial-sideband nature of the London transmissions, the received signal most nearly fits the video response curve of an American receiver if the oscillator frequency is 123 mc. However, results seem to be just about as good when working with an oscillator frequency of 33 mc and, since this frequency is easily measured with the gear available to the average experimenter, the oscillator coil shown is designed for 33 mc.



R1—1 megohm
R2—22,000 ohms
R3—330 ohms
R4—5,600 ohms
R5—4,700 ohms
All resistors ½ watt 10%
C1, 6—20 μμf mica trimmer
C2—3.9–50 μμf, variable (Hammarlund APC-50 or equivalent)
C3—1 μμf
C4, 7—.002 μf
C5—.01 μf
C8, 9—20 μμf
L1—4 turns, coupled to grounded end of L2, ⅛-inch spacing
L2—12 turns
L3—8 turns, ⅜-inch-diameter coil, tapped at 3rd turn
L4—5 turns, wound on ½-inch polystyrene coil form with L5, ⅛-inch spacing between coils, L5 at B-plus end of L4
L5—3 turns
All coils ½-inch diameter, self-supporting unless noted. Wound with No. 18 wire.
Turns spaced diameter of wire.
RFC—7 μh, 1,000 ma, 35–110 ohms (Ohmite Z-50 or equivalent)
VI—12AT7
Sockets, terminal strips, miscellaneous hardware.

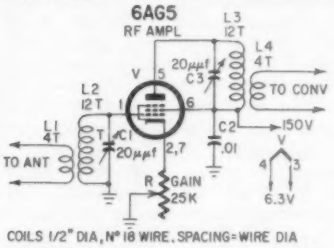
Fig. 3—Simple converter puts BBC on channel 5. Oscillator grid capacitor is C9.

What kind of antenna

Although it is true that the better the antenna the better the results, I had surprisingly good luck with rather simple aerials. I used a two-element beam in the attic for video reception. It was fastened between the rafters about 18 feet above ground. The antenna proper was a folded dipole cut from 300-ohm ribbon line. Behind it was a length of No. 18 wire which acted as a parasitic reflector. Dimensions are shown in Fig. 5. My sound antenna was a 300-ohm folded dipole without a reflector. Undoubtedly, performance would have been better if the antennas had been made of aluminum tubing and mounted high in the air, clear of surrounding objects. However, it was late fall when I started my experiments, and I like to do my sky-wire work when the weather is warm. It is worth noting that, even though the 45-mc transmissions are vertically

polarized, the receiving antenna can be mounted in a horizontal plane because the original polarization of the signal is lost as it passes through the ionosphere.

The best time of day to look for foreign TV signals is from around 0800-1300 EST. An all-daylight path is usually required between the transmitter and the receiver. Due to uncertain propagation conditions on the very high frequencies, it is difficult to say on what date long-distance reception will again be possible. I would suggest, though, that you be prepared to listen and watch not later than Oct. 15, 1958. Once you pick up programs in French at 41.25 and English at 41.5 mc on your sound receiver, you can be sure that conditions are optimizing. Keep checking 45 mc for the raspy buzz produced by the London video carrier. As soon as it comes through, you can try for a picture on the TV set.



COILS 1/2" DIA, N° 18 WIRE, SPACING=WIRE DIA
R—pot, 25,000 ohms
C1, 3—20 μμf, mica trimmer
C2—.01 μf
L1—4 turns, wound over cold end of L2, layer of electrical tape between coils
L2—12 turns
L3—12 turns
L4—4 turns, wound over cold end of L3, layer of electrical tape between coils
All coils wound on ½-inch diameter forms with No. 18 wire. Turns spaced diameter of wire.
V—6AG5
Sockets, terminal strips, miscellaneous hardware

Fig. 4—For more gain, use this preselector ahead of the converter shown in Fig. 3.

Tuning in for dx

Set the receiver's fine tuning at midrange on channel 5, or 6 if 5 is occupied in your locality. Tune the converter oscillator back and forth until the familiar out-of-sync zig-zag lines denoting a video carrier appear on the screen. The vertical hold control should stop the picture vertically, but you may have to readjust the horizontal oscillator transformer or ringing coil slug a bit before the horizontal hold control will bring the picture to a standstill horizontally. All the tuned circuits in the converter may now be adjusted to give you the sharpest image. You get the greatest contrast when all signal circuits are tuned to the same frequency. This arrangement, however, will result in a peaked response with low picture definition. Stagger tuning will reduce the gain, but will make for a better picture. TV dx tuning is an art that is a little hard to describe on paper. It is best learned by experiment.

Don't expect the pictures to be as sharp and steady as the ones you get from your local TV station. Since the ionosphere is a very imperfect reflector, the signals arriving at the receiver will travel several different paths. These paths are usually not of equal length, and numerous ghosts may appear on the screen, just as when you have multipath reflections on local TV signals. This ghost problem is often acute. Once, in a tennis match from overseas, there were at least 30 players batting 15 balls back and forth. The sync pulses, as well as picture elements, are subject to this ghosting effect. Consequently, there are often so many sync pulses of varying phase and amplitude that the receiver's circuits are unable to cope with them. At these times the picture jumps wildly up and down and sideways. Fairly often, however, ionospheric conditions settle down and a single, steady picture appears on the screen. Large objects, human faces and sometimes even program titles are then recognizable.

There are several explanations for the lack of sharpness in the image produced by a foreign TV signal. A certain amount of smearing appears because the if curve of an American receiver is not absolutely compatible with the signal transmitted from overseas. Ghost effects also tend to reduce the apparent sharpness. The selectivity introduced by the converter ahead of the TV receiver also contributes to loss of definition. Probably most important, however, is the fact that because of varying ionospheric conditions, it is seldom possible to receive all portions of the TV channel with equal strength. Another cause of picture degradation is the TVI produced by the many American mobile services operating between 40 and 50 mc.

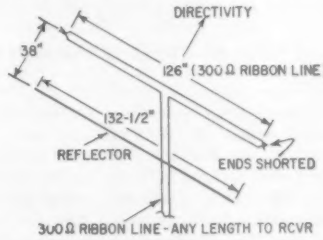


Fig. 5—Sketch of beam antenna for 45-mc TV reception.

When you get pictures on your TV screen direct from London, you'll undoubtedly want to photograph them to have a permanent record of your efforts. I used a 35-mm camera loaded with Plus-X film for the illustrations accompanying this article. Exposure was f 4.5 at 1/25 second. This shutter speed is optimum, as it is roughly equivalent to the scanning time required for one complete frame. [For more details on this type of photography, see "Photographing C-R Tube Images," RADIO-ELECTRONICS, February, 1958.]

Don't be surprised if the photos lack the sharpness and detail of the image you thought you saw on the TV screen. Remember, a camera lacks the human brain's ability to fill in the small details which it knows should be in a picture, even when they aren't. END

NEXT MONTH

READY FOR STEREO?

High-Fidelity author Don Hoefler tells newcomers to the stereo art what to do and what is needed to enjoy the latest development in the field of good music listening.

NEW COLOR TV CIRCUITS

Bob Middleton describes some circuits that differ in many respects from those we learned about when we were trying to master color TV.

USING THE NE-77 NEON TRIODE

This new low-priced 3-electrode neon lamp will do many things that could formerly have been achieved only with expensive thyratrons. Tommy Tyler tells how to use it.

Part II—Modern uhf tuners for today's TV set

NEW CIRCUITS in TV TUNERS

By E. D. LUCAS, JR.

LAST month we examined the standard and Fireball models of the Neutrode vhf tuner. Now we will see a uhf unit that fits piggyback on the standard neutrode model, and a miniature uhf tuner designed for current TV receivers.

Piggyback uhf tuner

Two principal approaches to the problem of tuning in uhf channels are used by Standard Coil designers. One is to install a type N4A uhf strip in place of any unused vhf channel's oscillator coil, and then to provide a separate uhf antenna input assembly. The second approach, preferred whenever several uhf as well as vhf channels are to be received or when the best uhf reception is desired, is to use the tiny Standard piggyback all-channel uhf tuner, illustrated in Fig. 5. This unit plugs into ND tuners of either the drum-turret or Fireball types, provided that these vhf tuners are equipped with a 13-position turret instead of the 12-position turret used in vhf-only receivers. That is, the ND tuners are made in both 12-position and 13-position versions, with the 13th position switching off the vhf oscillator and furnishing a path for the if signal output from the uhf tuner to the rf amplifier and mixer of the vhf tuner, which act as amplifiers for the if signal with the vhf oscillator cut off.

Looking at Fig. 6, the circuit of the piggyback uhf tuner, we see that the input from the 300-ohm antenna lead is inductively coupled by L23 to the two preselector lines indicated as L18 and L19. These are quarter-wave coaxial lines tuned by end capacitances varied by the tuning shaft's position. This input signal is heterodyned at the crystal mixer 1N82-A with an oscillator signal from the 6AF4-A oscillator circuit. This is a grounded-plate tuned-grid modified Colpitts oscillator. Note that the same tuning control that varies the end capacitance of the two preselector lines also varies the tuning capacitor in the oscillator grid circuit.

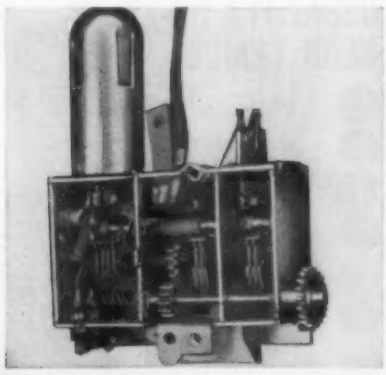


Fig. 5 — Piggyback all-channel uhf tuner.

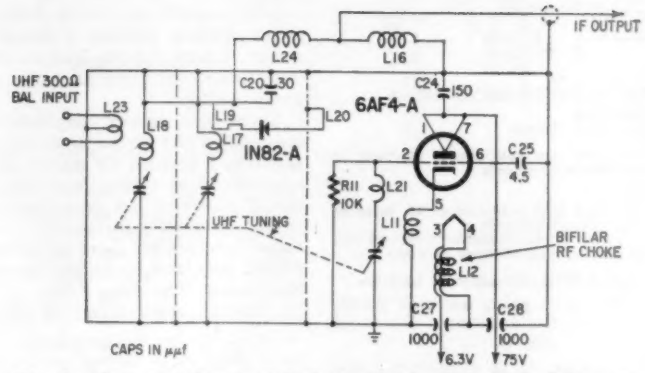


Fig. 6—Circuit of Standard Coil piggyback all-channel uhf tuner.

The if signal obtained at the 1N82-A mixer appears across inductances L24 and L16 which, with capacitor C20, form a circuit resonant at the 41-mc if frequency (actually 41.25 mc for sound). This if output is then fed through a coaxial cable to the 13th position of a vhf ND tuner, where it is amplified by the Neutrode vf amplifier and the pentode mixer, as previously mentioned.

The piggyback uhf tuner is 3.60 inches long, 2.312 inches high (not including oscillator tube and shield) and 1.157 inches wide. Power requirements are 75 volts at 16 ma and 6.3 volts for parallel heater circuits, 600 ma for series heaters. Noise factor is 17 db maximum when measured through the ND-4000 vhf tuner (turret of the drum type). Image rejection is 30 db minimum. Oscillator drift is less than 750 kc during a period of from 3 to 30 minutes of warmup, allowing for a temperature rise of 25°C.

Fig. 7 shows how the piggyback uhf tuner connects to the ND vhf tuner, utilizing what is called a channel-1 strip in the 13th position of the tuner. Note that the if signal from the uhf tuner—a weak signal, since there is no amplification in the uhf tuner, rather a 9–10-db loss in signal amplitude—is brought in through blocking capacitor C1 and coil L1 to the grid of the Neutrode triode. L2 serves as the rf amplifier (triode) plate coil and couples the amplified signal to L3, the mixer grid coil. Note that there is no oscillator coil, and the oscillator is cut off in the channel-1 or uhf position.

The combined amplification of the triode and the mixer pentode in the uhf tuner, acting on the if signal from the uhf tuner, gives a voltage gain between

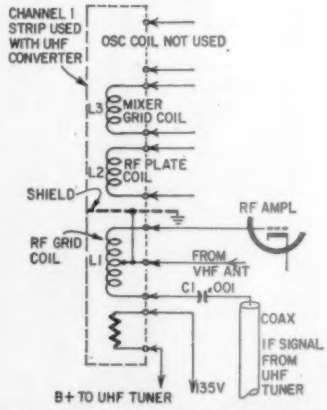


Fig. 7—How Standard Coil uhf tuner is connected to Neutrode vhf tuner.

46 and 50 db. Thus there is ample gain in these two stages to boost the weak uhf signal at the intermediate frequency, to about the same level as the if output of the vhf tuner, so that either signal enters the first if amplifier stage at approximately the same level.

Referring to Fig. 7 again, note that in this position the vhf antenna input is shorted to ground. This is very important, so that no interfering signals in the 41- to 46-mc range come in to "hash up" the desired if signal from the uhf tuner. Also the 135-volt B-plus is fed to the uhf tuner (requiring only 70 volts) through a dropping resistor.

The alternate method for uhf reception in Standard Coil tuners consists of a special coil board for each uhf channel desired. Obviously this technique is practical only where the total number of desired vhf and uhf channels does not exceed 12. In a uhf coil board, the oscillator consists of a crystal acting as a harmonic generator to produce the desired harmonic of the oscillator in the vhf tuner, such as the third or fifth harmonic. This signal is heterodyned with the received uhf signal in a 1N82-A mixer to produce an if signal which again is amplified in two stages in the vhf tuner.

General Instrument model 204

Even smaller in size and excellent in performance is another all-channel uhf tuner, the model 204 developed by General Instrument Corporation's F. W. Sickles Division. This unit, shown in Fig. 8, is 2.69 inches square by 1.375 inches deep and weighs a mere 13 ounces. Its square-shaped construction is held to be a factor in improved stability and ease of mounting, helping to keep the tuner on the desired station even if the receiver is moved or jiggled. Numerous mounting holes and provisions for adding a variety of tuner drive mechanisms contribute to the versatility of this uhf midget. Most important feature of the design, however, is that it can be produced at low cost compared to previous all-channel models and hence has marked appeal for set makers who want to offer improved uhf reception at a reasonable price.

When we look at the circuit in Fig. 9, we can see how closely the circuit design of the model 204 parallels that of the piggyback uhf tuner. Again we find a 6AF4-A oscillator tube (or its series equivalent) and a crystal diode type (1N82-A or equivalent) mixer-converter producing an if signal output. Evidently, this is again a single superheterodyne receiver with no rf amplification ahead of the mixer, and with a variable capacitor assembly used for tuning.

According to General Instrument engineers, they decided that the most profitable area in which to concentrate design efforts was improving the design of the preselector and oscillator coaxial lines which, with the variable capacitors, form the basic tuning elements.

Looking at Fig. 9, we see two pre-

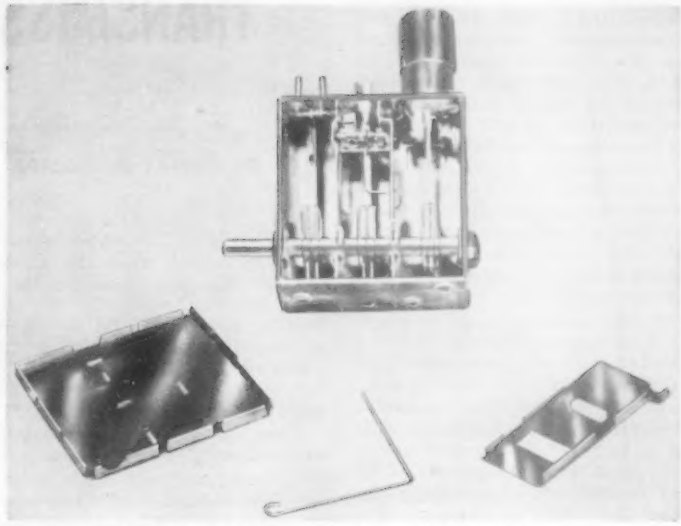


Fig. 8—General Instrument's model 204 uhf tuner.

selectors, each a quarter-wave coaxial line tuned by an end capacitance. Two preselectors assure sufficient skirt selectivity. A single one would mean lower insertion loss and hence a better noise figure, but image-rejection specifications of 40 db minimum require two preselectors to function efficiently at the bandwidths and if frequencies specified. Another important consideration, in addition to image rejection, is that the two are needed to guarantee adequate blocking of the local oscillator frequency, which is about 43.5 mc (picture) above the signal frequency. Without this blocking, oscillator radiation at the antenna terminals would exceed the limits set by the FCC.

In designing a preselector circuit, the loaded Q of the circuit is governed by skirt selectivity—that is, image-rejection and oscillator-radiation specifications. Since the insertion loss of a preselector varies inversely as the unloaded-to-loaded Q ratio, a high unloaded Q is undesirable. Loaded Q's in uhf tuner preselectors are typically from 25 to 50. To keep insertion loss below 0.5 db per preselector requires an unloaded-to-loaded Q ratio of 20. Thus unloaded Q's should range from 500 to 1,000. The unloaded Q depends on the impedance of the coaxial line and the length of that line, while impedance depends on the dimensional relationship between inner and outer conductors.

Another design criterion for these uhf preselector lines is the ability to tune over the entire frequency range from 470 to 890 mc with a small set of capacitor plates. Again the amount of tuning capacitance required becomes a function of the impedance and length of the coaxial line. In the model 204, the length of the two preselector lines has been reduced from 3 inches each—a typical figure for earlier tuners—to only 2-7/16 inches. One result has been reduced size and spacing of capacitor plates. This permits notably smaller overall tuner size as well as greater efficiency. In addition to reducing preselector line length, the designers of this new tuner have chosen cross-section dimensions to achieve a line impedance close to the optimum Q while maintaining sufficient tuning bandwidth.

Other factors in preselector design are correct setting of the loadings at

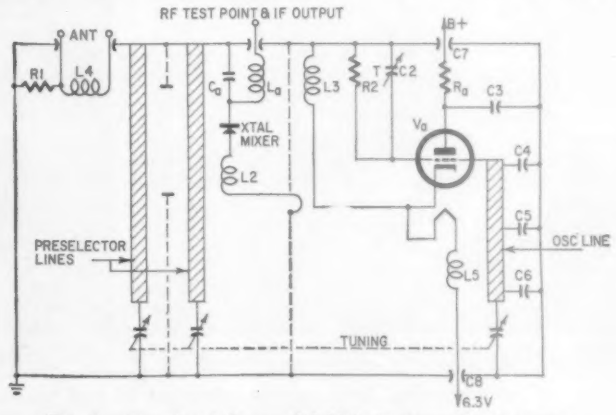


Fig. 9—Circuit of the model 204 all-channel uhf tuner.

antenna and mixer, as well as the coupling between these two circuits. These adjustments are made so that there is a slight overcoupling at the extremes of the uhf range and critical coupling at midband. Loadings are set by careful design of the shapes, and correct location, of the antenna and mixer coupling loops in the coax lines.

A second major factor in improved uhf tuner design demonstrated in the model 204 is a better oscillator circuit. Basically, this is a ground-plate tuned-grid modified Colpitts oscillator which must meet four principal criteria:

1. Sufficient output to drive the mixer crystal at an efficient level.
2. Power output low enough to avoid excessive radiation.
3. Low thermal drift.
4. Essentially linear frequency calibration.

There must be a compromise to satisfy the first two requirements. In the model 204, these requirements are met by an oscillator circuit that operates satisfactorily with a B-plus as low as 40 volts, assuring a low radiation figure.

The third design problem, keeping thermal drift low, can also be solved only by compromise. Adding drift-compensating capacitors lowers the maximum frequency obtainable with a given impedance. Modifying the impedance to permit adding capacitance results in decreased oscillator efficiency. A further handicap is that in miniature tuners, because of their construction, there is a greater amount of minimum capacitance than in larger turners. Hence, full drift compensation has heretofore been possible only with these bigger tuners. But the importance of proper compensation has been greatly increased with the advent of color TV since a relatively slight change in frequency causes loss of color in the picture. With the compensation provided by the designers of the model 204, this tuner has a maximum drift of about 200–300 kc. This advance in oscillator stability should make the tuner popular with users as well as receiver manufacturers and service technicians.

To achieve linearity, it is necessary to eliminate, detune or decouple each possible absorbing element; to reduce ground currents to a minimum, and to maintain oscillator activity at a uniform level throughout the uhf band. General Instrument designers state that they have been successful in eliminating the resonances and nodal points typical of uhf oscillators, thus getting rid of the dead spots which make necessary unduly high output at some frequencies to compensate for these low activity points.

By a combination of electromechanical improvements in the design of the two preselector lines and the oscillator circuit, engineers responsible for the model 204 have vastly reduced the size of this uhf tuner and have also achieved real advances in performance, both electronic and mechanical. END

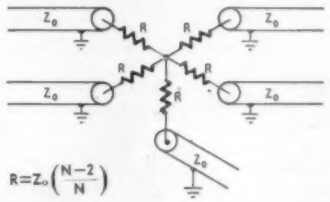
TRANSMISSION-LINE MATCHING

By HENRY A. KAMPF

Resistance match three or more lines to one antenna

CONNECTING three or more transmission lines poses the problem of proper impedance matching to minimize standing waves in the system. Ideally, lines would be matched with rf impedance-matching transformers which do not dissipate energy. Therefore the rf power would be equally divided among all of the lines.

Lines can also be matched properly with ordinary ½-watt carbon resistors,



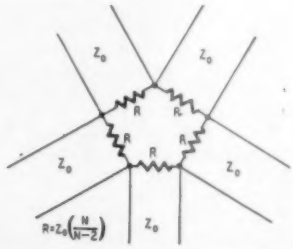
VALUES OF R						
Number of Lines(N)	Characteristic Impedance (Ohms) 50	73	150	300	375	Db Loss = 20 x log(N−1)
2	0	0	0	0	0	0
3	17	24	50	100	125	6.02
4	25	37	75	150	188	9.54
5	30	44	90	180	225	12.04
6	33	49	100	200	250	13.98
7	36	52	107	214	268	15.56
8	38	55	112	225	282	16.90
9	39	57	117	234	292	18.06
10	40	58	120	240	300	19.08

Fig. 1—Series connecting coaxial lines. All lines have a common ground.

if the lines all have the same characteristic impedance and if the power lost in the resistors does not reduce the signal below a usable level. This condition occurs in strong-signal areas where several receivers are connected to a common antenna. Any mismatch can cause standing waves which appear as ghosts on the TV screen. In such areas reduction in signal strength is not important but the match of the rf lines is quite critical. Similar situations occur with test equipment and occasionally in amateur applications.

When matching with resistors, two connections are possible. The series resistor connection is used for lines having a common ground, such as coaxial cables. The shunt resistor connection can be used with balanced lines. Figs. 1 and 2 show how the matching networks are connected and give the formulas for calculating the necessary resistor values. The symbols used in the equations are: Z_o—characteristic impedance of the transmission lines used; N—total number of lines that are joined; R—resistor value required in the diagrams.

When one of these lines is a signal source, the loss of the network for this signal down to any one of the other lines is calculated from the equation $L = 20 \log (N - 1)$, where L is the loss in db. This equation is the same for either the series or shunt connection. In the examples of Figs. 1 and 2 five lines are joined; therefore, N is 5. If 300-ohm transmission lines are used, Z_o is 300. Substituting these values into the equations we find that the required resistance R is 180 ohms for the series connection and 500 ohms for the shunt connection. The signal strength appearing on any one of the lines will be 12.04 db down from the signal applied to any one of the other lines. END



VALUES OF R						
Number of Lines(N)	Characteristic Impedance (Ohms) 50	73	150	300	375	Db Loss = 20 x log(N−1)
2	∞	∞	∞	∞	∞	0
3	150	219	450	900	1125	6.02
4	100	146	300	600	750	9.54
5	83	122	250	500	625	12.04
6	75	110	225	450	562	13.98
7	70	102	210	420	515	15.56
8	67	97	200	400	500	16.90
9	64	94	193	386	482	18.06
10	63	91	188	375	469	19.08

Fig. 2—Shunt connecting two-lead lines.

TV Service CLINIC

conducted by

ROBERT G. MIDDLETON
TELEVISION CONSULTANT

WE usually use a color bar generator at the bench to troubleshoot color sync circuits. This type of signal makes troubleshooting easier because we can adjust the burst voltage to low values to spot the point at which the receiver loses color sync. The burst voltage can be adjusted independently of the color bar voltage in most generators, as shown in Fig. 1.

When the color bar pattern loses color sync, each color bar breaks up into rainbows. We know that the order of colors in a rainbow shows whether the subcarrier oscillator is running above or below 3.58 mc. *Each* color bar always shows the *same* order of colors in the rainbow, as in Fig. 2. However, the rainbows *start* at *different* points in each color bar.

The rainbows are "staggered" in the various color bars because each color has a different phase. When the subcarrier oscillator loses color sync, each bar breaks at the same instant, *at the phase which defines its particular color.* Hence, we find the green in the *green* bar next to green and red in the *yellow* bar (red plus green gives yellow).

We find the blue in the *blue* bar next to blue and green in the *cyan* bar (blue plus green gives cyan). We find the red in the *red* bar next to red and blue in the *magenta* bar (red plus blue gives magenta). Of course, we see no rainbows in the white and black bars, because white and black are not colors.

Fig. 1 — Burst amplitude (left) nearly normal; (right) reduced to one half, chroma bars unchanged.

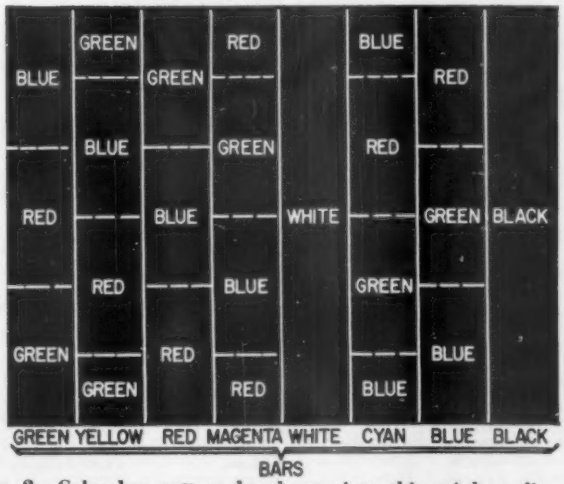


Fig. 2—Color bar pattern breaks up into this rainbow display when subcarrier oscillator runs 60 cycles *below* 3.58 mc.

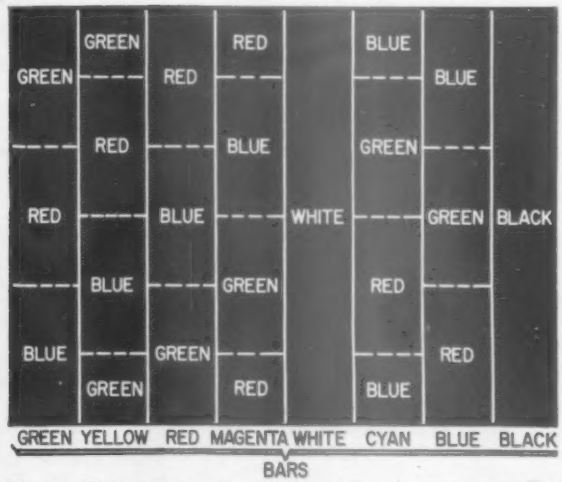


Fig. 3—This pattern, the reverse of Fig. 2, appears when the subcarrier oscillator runs 60 cycles *above* 3.58 mc.

Fig. 2 shows the series of colors in the rainbows when the subcarrier oscillator is running below 3.58 mc. If the oscillator runs above 3.58 mc, the series of colors reverses, as in Fig. 3.

Finally, let us consider the situation in which the color subcarrier oscillator is running almost, but not quite, on 3.58 mc. When this happens, we see the entire field slowly drift in color. For example, the red bar will be red for a while, and the blue bar will be green. But next, the red bar turns blue for a while and simultaneously the blue bar turns green for a while, etc.

Too much width

There is about 1½ inches too much width on a Motorola portable model 14P8 and no width control. Can you suggest something?—C. T. G., Jersey City, N. J.

Too much width can be corrected in several ways. The simplest is to slide a sleeve of aluminum foil partially under the yoke to obtain desired width.

Bad focus

A 12JP4 tube in a DuMont RA-103 can be focused sharply for the center 6 inches, but does not have good edge focus. The focus coil is supposed to have a resistance of 550 ohms, but is 500 ohms. The picture tube is getting old, but still has good brightness and contrast. Should the focus coil be replaced? —C. N., New York, N. Y.

A resistance measurement of 500 ohms on a coil rated at 550 ohms is within tolerance. A new coil is not required. The voltages on the picture-tube electrodes should be checked, especially the first anode. If voltages are OK, the old picture tube would be next in line for suspicion.

Big screen to bigger screen

I would like to convert an RCA 21S510 from a 21AMP4-A picture tube to a 24CP4-A. Is this practical?—H. M., Brooklyn, N. Y.

This change is quite possible but, since you are going from a 70° to a 90°

tube, you will require a new yoke and flyback. A larger vertical output transformer is also necessary. We suggest that you obtain a standard 90° conversion kit. Some mechanical changes, of course, are also required to accommodate the larger tube.

More on the KCS-47

I note R. W.'s trouble (February, 1958) with an RCA KCS-47, and would like to pass along some further data:

"The vertical output transformer winding is bypassed by two .047-μf 1,000-volt capacitors (see Fig. 4). They bypass each side to ground and are

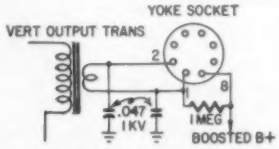


Fig. 4—Failure of bypass capacitors can cause yoke breakdown.

located behind the yoke plug socket. I have seen many of them short to ground. This places B-plus boost voltage between the horizontal and vertical windings."—*L. P., College Park, Md.*

Tuner doesn't work right

A Standard Coil tuner model 5001 does not operate properly in a Muntz 37A4, although both have 21-mc circuits. The slugs fall out before a satisfactory adjustment can be made. Capacitor adjustment in the oscillator section does not bring the tuner into range.—T. E. C., Cedartown, Ga.

When the tuner was installed, the alignment of the first if stage was undoubtedly changed. The set's if passband must match the tuner's output passband. Use a good sweep and marker generator and scope to check the response. It is also advisable to make an rf alignment of the tuner. This will undoubtedly solve your difficulty.

Boost brightness

How can I increase screen brightness without using higher voltage or getting more scanning width? — J. W. L., Wayne, W. Va.

Your letter does not state the operating value of high voltage which you now have. Sometimes, it is possible to use an aluminized picture tube to get more brightness and contrast than with a nonaluminized tube. However, you must have working voltage for the aluminized tube that you use. Less than rated voltage will prevent the aluminized tube from giving any advantage.

Audio interference

A Sylvania 21C501 developed AM audio interference on channel 8, but not on channel 3. The channel 8 station is 50 miles distant. New tubes and a line filter have not helped. The interference can be eliminated by detuning the fine-tuning control, but this deteriorates picture quality. Could an oscillating AM receiver in the neighborhood cause this trouble? — A. L. G., Manila, P. I.

If no new high-powered AM station has been put into operation in your vicinity, I would expect that a reradiating AM receiver is responsible for the interference. Cross-modulation can cause interference when the AM field strength is high. A good TV high-pass filter in the lead-in might kill the interference. A new AM station could also radiate enough harmonic energy, possibly, to interfere with a TV transmission 50 miles distant. This can only be eliminated by using a narrow-beam antenna. Such an antenna may also help in eliminating interference from reradiating AM receivers.

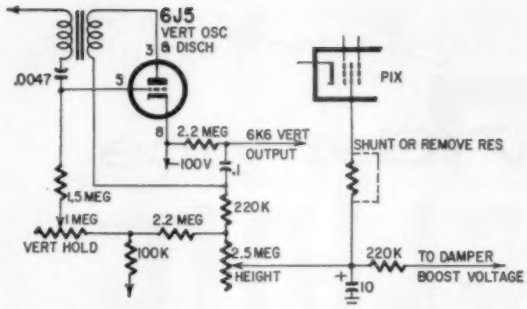


Fig. 5—Circuit to prevent spot formation.

Kill that spot

Several years ago I assembled a TV receiver kit which works well, except that a bright spot remains after switching the set off, and eventually burns the screen of the picture tube. What can I do? — R. F. C., Los Angeles, Calif.

You should use a spot killer, as described in *Television Technotes*, published by the Gernsback Library. Since you do not mention the model of your kit receiver, I cannot make specific suggestions, but will repeat the advice published in the book:

Spot killer

"This circuit modification prevents formation of the intense spot of light that appears in the center of many TV screens immediately after the set is turned off. In most TV sets the picture tube first anode is supplied from some point in the power supply proper. Fig. 5 shows how a popular RCA circuit can be modified so that the first anode is supplied directly from the arm of the height control which usually obtains its voltage from the damper-boost circuit. If the original circuit has a resistor in series with the first anode, remove it.

"This circuit also aids in eliminating the brown spot seen on kinescope screens after some use. Although the circuit shown is applied to the 630-type set, there is no reason why it cannot be applied in other receivers.

"Take care when adding this circuit to sets having large picture tubes, because the boosted voltage may exceed the maximum voltage which may be applied to grid 2. If the voltage exceeds 400, use a voltage divider."

17- to 21-inch conversion

Can a Motorola TS-118 using a 17AP4 be converted for a 21-inch tube? —W. J. H., Astoria, N. Y.

The best choice of a 21-inch tube will be a 21EP4. This tube is comparatively easy to sweep, and it is likely that no electrical changes will be required. However, if some nonlinearity occurs, the yoke can be changed.

Kinks in the raster

I built a 10-inch TV kit which has two kinks in the raster about 3 inches apart. Both kinks are affected by the vertical-hold control. The vertical oscillator (Fig. 6) uses a 6C4 and a scope at the grid or plate shows a crawl in the waveform. I cut the vertical oscillator out of the circuit and used a separate power supply, with no improvement. — D. W. T., Longview, Tex.

Your first check was well directed. It shows that the spurious voltage is not entering through the height control, but is coming in through the integrator. Continue your scope checks step by step back from the integrator, to see where this spurious voltage first enters the circuit. A low-capacitance probe can be used back as far as the picture detector. A demodulator probe must be used in the if strip. END

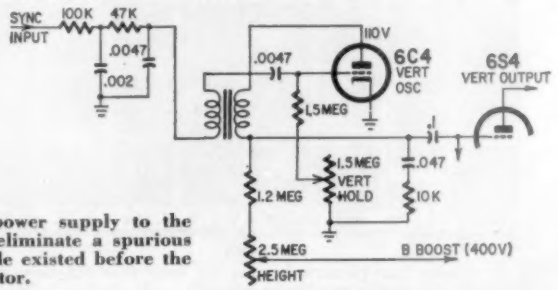


Fig. 6 — A separate power supply to the height control did not eliminate a spurious voltage, when the trouble existed before the integrator.

fm tv dx

By ROBERT B. COOPER, JR.

IN our June column, we discussed briefly how to count a logging of a station if it should change channels, increase power, move transmitter location, etc. This section was designed to clarify the statistics problem, bringing every dxer to an even operating plane.

From comments received, the suggested standards have met with fairly universal acceptance, although some dxers did lose a "station or two" in their totals tabulation. In a future column, we will have more to say about standards for the nationwide-minded dxers, as opposed to the isolationists. Meanwhile, we suggest that you go over your own totals and get them ready to mail to the TV Dx column before Oct. 15.

Send along your latest complete station total, uhf station total and best distance on each of the three bands (channels 2–6, 7–13 and 14–83). This information will be used in preparing the January, 1959, listing of all dxers with over 50 stations to their credit.

Trops bending session

For several years, the last week of May has produced at least one widespread ground-wave dx opening throughout the Midwest and Great Lakes area. At the height of these sessions, distances of 500–700 miles have been covered frequently on the high-band vhf channels (7–13).

This year produced a similar session, although it was not nearly as evident as in past years. Noted as early as 1930 hours on June 3 by Walter Owens, Jr. of Springfield, Ohio, who logged KCRG-TV, channel 9, Cedar Rapids, Iowa (490 miles), the last reported logging of this trops session was on the morning of the June 6 when Clark Conaway of Knightstown, Ind., logged WTRF-TV, channel 7, Wheeling, W. Va., some 450 miles. Many similar loggings (400–600 miles, high band) are reported by dxers David Novick, of Shorewood, Wis., and Albertus Hoogeveen, of Lansing, Ill.

Other than the two Mexican stations located on the Mexico–California border, Western US dxers seldom, if ever, see television stations from our nearest neighbor to the south. However, on May 25, reception from Calexico (border station), Monterrey and Mexico City stations (double hop) was reported throughout the West. Seen in Boise, Idaho, as early as 1730 PST by Ed Brawley and as late as 1930 by Ron Pugh, Fort Bragg, Calif., stations XEW-TV, channel 2, XEZ-TV channel 3; XHGC-TV, channel 5; XHNL-TV, channel 2; XEM-TV, channel 3 were reported in varying degrees in many dxing locations.

FM dx

One of the first FM skip openings to come to our attention since the inception of this portion of the vhf dxing column, occurred on the evening of June 19, between the Middle Atlantic and Midwestern states. M. Harvey Gernsback of Plainfield, N.J., reports reception from WOI, Ames, Iowa, on 90.1 mc, and tentative reception of KANB, Lawrence, Kans., on 91.3 mc. Three stations, operating on 88, 90.3 and 91.9 mc, also skipping in with the same program material, were believed to be part of the Wisconsin State Educational net.

Bernard S. Gurman of Malden, Mass., notes a ground-wave haul from WGH, 97.3, Newport News, Va.

Another chap who has had some good luck with FM skip dx is Clifford Violette, of Gardner, Mass. Dxer Violette reports excellent skip reception on the morning of June 20, from WEAU, 94.1 mc, Eau Claire, Wis.; WJMC, 96.3 mc. Rice Lake, Wis.; WHRM, 91.9 mc, Wausau, Wis.; WHWC, 88.3 mc, Colfax, Wis., and WHAD, 90.7 mc, Delafield, Wis., all approximately 1,100 miles distant. Checking the TV band at this same time, he found WKZO-TV, channel 3, Kalamazoo, Mich., and KDAL–TV, channel 3, Duluth, Minn., breaking through the snow barrier.

One of the top FM dxers in the country, Bruce Elving, Duluth, Minn., reports on his totals. In 9 years of FM dxing, Elving has logged 311 stations from 32 states, the District of Columbia and Quebec. His greatest distance loggings include St. Petersburg-Tampa, Fla. His present equipment is a Harman-Kardon Theme tuner, while the antenna consists of double-stacked five-element Yagis on a rotator.

FM and metropolitan dxers

Unlike the television dxer, the FM dx fan can and does survive in crowded metropolitan areas. Even in the most heavily populated areas along the Eastern seaboard, the FM band is filled with "clear spots"—frequencies on which dx stations can sneak through. Using sharp-patterned Yagi antennas and selective tuners, the vhf dx enthusiast will find that dx reception is much more reliable and easier to work with on the 100 FM channels than on the 12 vhf TV channels (when 7 are occupied by locals!).

DX predictions

After a summer of violent and prolonged displays of E skip, the "fair-weather" dxer will be dismayed to find action dwindling greatly during the next three months. However, dxers in the southern sections of the country will be treated to E-skip openings until mid-September, mostly involving east–west paths in the early evening (and late afternoon) hours.

This September should produce many brilliant auroral displays and, coinciding with the beginning of such visual displays, east–west skip paths across southern Canada and the extreme northern United States should be covered via Es. Such auroral–Es openings are normally mid-evening occurrences accompanied by violent fading of both the audio and video signals.

During the last week of August, TV and FM dxers should notice a marked upturn in ground-wave coverage. A gradual upturn in reception from fringe-area stations is a sign of something special brewing and should provide the incentive necessary to hold the dxer close to his set.

Keep an eye on weather maps in daily papers and on TV weather shows. A large, slowly moving, "high" frontal zone headed into your area is the key to excellent extended ground-wave reception on all TV channels (2–83) and the FM band. Late-evening and early-morning "localized" ground-wave reception will continue to be good over the Central Plains area and throughout the South into October.

The months of September and October can produce a spectacular meteor shower or two, but unfortunately this is not one of the years that they do. Oct. 2 will bring a secondary shower, the Quadrantids, which peaks on basic east–west skip paths from 0900 LST (Local Standard Time) to 2000 LST. Oct. 12–23 is another good period for the burst enthusiast, as the Arietids shower brings good north–south radio-path meteor-burst reception. (North–south depicts a Great Circle path such as Chicago to New Orleans, while east–west describes signal propagation between points such as Kansas City and Baltimore.)

The best hours for the Arietids are from 2130–2330 and 0230–0430 LST. Dxers on both the TV and FM bands would do well to watch these dates and times closely for possible new loggings.

With the coming of fall, F2 skip returns to the Northern Hemisphere. Late October mornings should bring frequent reception of BBC-TV, London, on European channel 1, to those dxers set up to receive British standards and

(*Continued on page* 78)

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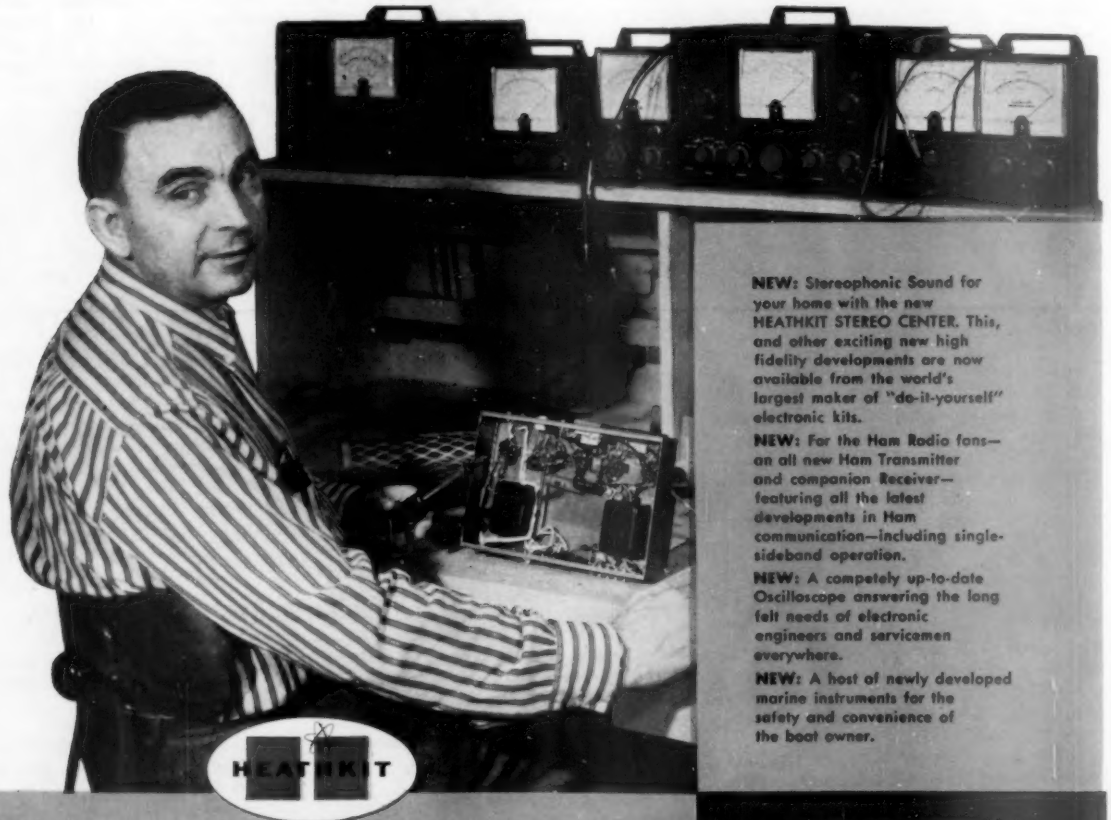

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HEATHKIT

ETCHED CIRCUIT VTVM KIT

The fact that this instrument is outselling all other VTVM's says a great deal about its accuracy, reliability, and overall quality. The precision and quality of the components used in this VTVM cannot be duplicated at this price through any other source. Its attractive appearance as well as its performance will make you proud to own it. A large 4½" panel meter is used for indication, with clear, sharp calibrations for all ranges. Front panel controls consist of a rotary function switch and a rotary range selector switch, zero-adjust and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuit. An etched circuit board is employed for most of the circuitry, cutting assembly time and eliminating the possibility of wiring errors. It also assures duplication of laboratory instrument performance. This multi-function VTVM will measure AC voltage (RMS), AC voltage (peak-to-peak), DC voltage and resistance. There are 7 AC (RMS) and DC voltage ranges of 1.5, 5, 15, 50, 150, 500 and 1500. In addition there are 7 peak-to-peak AC ranges of 0-4, 14, 40, 140, 400, 1400 and 4,000. Seven ohmmeter ranges providing multiplying factors of x 1, x 10, x 100, x 1000, x 10 k, x 100 k and x 1 megohm. Center scale resistance readings are 10, 100, 1000, 10 k, 100 k ohms, 1 megohm and 10 megohms. A zero-center scale db range is also provided. Battery and test leads included with kit. Shpg. Wt. 7 lbs.

HEATHKIT V-7A **$24.50**

World's largest selling VTVM kit

★ LARGE EASY-TO-READ 4½" 200 UA METER
★ 1% PRECISION RESISTORS EMPLOYED FOR HIGH ACCURACY

HEATHKIT C-3 **$19.50**

Checks all types of condensers accurately

HEATHKIT T-4 **$19.95**

Locate faults quickly by tracing signals

HEATHKIT SG-8 **$19.50**

Easy-to-build—prewound and calibrated coils

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately. Capacity measurements are made in four ranges of .00001 mfd-.005 mfd; .001 mfd-.5 mfd; .1 mfd-50 mfd; 20 mfd-1,000 mfd. Checks paper, mica, ceramic, and electrolytic condensers. Leakage test provides switch selection of five polarizing voltages, 25 volts to 450 volts DC to indicate condenser operating quality under actual load conditions. Electron beam "eye" tube indicates balance and leakage. A spring return test switch automatically discharges condenser under test and eliminates shock hazard to the operator. Measures resistance from 100 ohms to 5 megohms in two ranges. Shpg. Wt. 7 lbs.

VISUAL-AURAL SIGNAL TRACER KIT

Here is a brand new signal tracer completely redesigned with compact dimensions and new circuit layout. Features built-in speaker and electron beam "eye" tube for signal indication and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. RF and audio inputs are provided in one convenient probe with switch on probe to select either input. Useful for checking microphones, phono cartridges, record changers, tuners, etc. Makes a handy substitution speaker for servicing TV sets at the shop. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 6 lbs.

RF SIGNAL GENERATOR KIT

Save valuable time in aligning RF tuned circuits of all kinds with this easy-to-use kit. Also a quick way to trace signals in faulty RF, IF and audio circuits. Designed for general service applications-the SG-8 covers 160 kc to 110 mc on fundamentals in five bands, and from 110 mc to 220 mc on calibrated harmonics. The entire oscillator circuit is built on a special sub-chassis, using prewound and calibrated coils. No further calibration is required so it is ready to use as soon as construction is completed. RF output is in excess of 100,000 microvolts, controlled by both step and continuously variable controls. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

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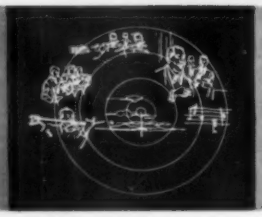


Enjoy Rich 3 Dimension Sound...

Beautifully Styled with Plenty of Room for the Most Complete Stereo System

AVAILABLE IN THE FOLLOWING MODELS:
Model SE-1B – Stereo Equipment Cabinet (birch)
Model SE-1M – Stereo Equipment Cabinet (mahogany)
$149.95 ea.

Model SC-1BR – Stereo Wing Speaker Enclosure (birch – right end)
Model SC-1BL – Stereo Wing Speaker Enclosure (birch – left end)
Model SC-1MR – Stereo Wing Speaker Enclosure (mahogany – right end)
Model SC-1ML – Stereo Wing Speaker Enclosure (mahogany – left end)
$39.95 ea.

AVAILABLE AFTER JUNE 30

STEREO EQUIPMENT CABINET KIT

Imagine! . . . Stereophonic sound in your own home. This superbly designed cabinet holds all of your hi-fi stereo equipment and lends striking elegance to your living room. The attractive gold and black panels, trim and hardware brilliantly highlight the overall effect. Rich toned grille cloth, flecked in gold and black, complement the cabinet. The unit has ample room provided for an AM-FM tuner, tape deck, stereo preamplifier, amplifiers, record changer, record storage and speakers. Beautifully grained ¾" solid core Philippine mahogany or select birch plywood is used for construction. The top features a shaped edge and sliding top panel for easy access to the stereo tape deck and stereo preamplifier. Sliding doors are employed for convenient front access to the changer and record storage compartment. All parts of the cabinet are precut and predrilled for simple assembly. The speaker wings and center cabinet may be purchased separately if desired. Note: the kit is delivered equipped with panels precut to accommodate Heathkit components and also blank panels to cut out for your own equipment. Measurements of the individual component areas follow: tape deck and preamplifier area 20¾" L. x 17¾" W. x 10" D., record changer area 21" W. x 16" D. x 9⅝" H., record storage area 22⅝" W. x 14½" H. x 12½" D., speaker wing area (inside) 14" W. x 29½" H. x 15¾" D., AM-FM Tuner area 20½" W. x 5¼" H. x 14" D., amplifier (2 areas) 15¼" W. x 10¾" H. x 13¼" D.

Model HH-1B Birch
Model HH-1M Mahogany
Now only **$299.95** each

The Same Superior Performance At a New Low Price

HEATHKIT SS-2 **$39.95**

OPTIONAL LEGS EXTRA

Economical Hi-Fi For Your Home

"LEGATO" HI-FI SPEAKER SYSTEM KIT

The increasing sales of the Legato has made more economical quantity production possible so we are passing the savings on to you by offering you this magnificent speaker system at a reduced price. Truly a "queen" among hi-fi speaker systems, the Legato was specially designed to meet and surpass the most stringent requirements of high fidelity sound reproduction. Two 15" Altec Lansing low frequency drivers cover frequencies of 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. A unique crossover network is built in making electronic crossovers unnecessary. Internal reflections are absorbed by splayed back panel and a 3" fiber glass lining. The Legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Cabinet construction is ¾" veneer surface plywood in either African mahogany or white birch and measures 41" L. x 22¼" D. x 34" H. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

True high fidelity performance at modest cost make this basic speaker system a spectacular buy for any hi-fi enthusiast. The amazing performance of this popular kit is made possible by the use of high quality speakers in an enclosure specially designed to receive them. The cabinet is a ducted port bass reflex type enclosure 11½" H. x 23" W. x 11¾" D. It features an 8" mid range woofer to cover 50 to 1600 CPS and a compression-type tweeter with flared horn covering 1600 to 12,000 CPS. Both speakers are by Jensen. The adjustable flared tweeter horn allows speaker to be used in either upright or horizontal position. The cabinet is constructed of ½" veneer surfaced plywood suitable for light or dark finish of your choice. All wood parts are precut and predrilled for easy assembly. Shpg. Wt. 25 lbs.

Attractive brass tip accessory legs convert SS-2 into attractive consolette. Legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26 $4.95

with a Heathkit Stereo System

HEATHKIT

HIGH FIDELITY STEREO TAPE DECK KIT

For your unparalleled enjoyment in the world of stereophonic sound Heathkit brings you an all new stereo tape deck. This tape deck is a precision engineered instrument providing monaural record/playback, and stereo playback of prerecorded tapes. Incorporates three separate heads, erase-record-stereo playback (stacked). The mechanical tape deck assembly is supplied complete. You build only the record and playback circuit employing two etched circuit boards for ease of wiring. Low noise EF-86 tubes in input stages and efficient push-pull bias-erase oscillator insures complete freedom from hum and noise in recording and playback. Provision made for 3¾ and 7½ IPS tape speed selected by a push button. Deck handles up to 7" reels of tape. Other features are: provision for monitoring tape while recording, built in VU meter for proper recording level, pause control for editing tape, "fast forward" and "rewind" control. Frequency response at 7½ IPS tape speed is ±2 db from 40 to 12,000 CPS, at 3¾ IPS speed 40 to 6,000 CPS. Signal-to-noise ratio is 55 decibels with less than 1% total harmonic distortion. NARTB tape playback equalization. A safety interlock button prevents accidentally switching to record position causing erasure of recorded tapes. Shpg. Wt. 33 lbs.

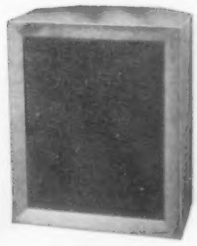
Model TR-1C monaural tape deck incorporates all of the features described for the model TR-1D with the exception of stereo playback. $131.95.

No. C-TR-1C conversion kit converts model TR-1C to include stereo function of model TR-1D. $15.95.

HEATHKIT TR-1D $143.95

Preassembled Tape Mechanism . . . You Build Only Electronic Circuit

AVAILABLE AFTER JUNE 30



HEATHKIT SS-1B $99.95

Fill out the Hi-Fi Range of Your SS-2 Speaker

AVAILABLE AFTER JUNE 30

HEATHKIT SW-1 PRICE TO BE ANNOUNCED

Save Time Rewinding Tape

HEATHKIT TK-1 $9.95

All The Tools You Need For Building Heathkits

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

This is not a complete speaker system in itself, but is designed to extend the range of the SS-2. The SS-1B uses a 15" woofer and a small super tweeter to supply the very high and very low frequencies to fill out the response of the basic SS-2. The SS-2 and SS-1B when used together, form an integrated four speaker system. The SS-2 and SS-1B combination provide an overall response of ±5 db from 35 to 16,000 CPS. The kit includes circuit for crossover at 600, 1600 and 4,000 CPS. Impedance is 16 ohms and power rating is 35 watts. A control is also provided to limit output of super tweeter. The handsome cabinet measures 29" H. x 23" W. x 17½" D. Constructed of beautiful ¾" veneer surface plywood. Complete step-by-step instructions make this kit easy to build. No woodworking experience required. Shpg. Wt. 80 lbs.

"SPEEDWINDER" KIT

This handy device leaves your tape recorder free for operation while it rewinds tape at the rate of 1200' in 40 seconds. Prevents unnecessary wear to the tape and recorder by eliminating wear against guides and heads. It will handle up to 10½" tape reels as well as 800' reels of 8 and 16 millimeter film. A very useful aid to operators of movie projection equipment. The Heathkit Speedwinder features an automatic shutoff which prevents whipping of tape when it has rewound. A manual shutoff is also provided. An automatic braking device is built in for protection against power failure. Driven by a heavy duty four pole motor. Handsome cabinet is constructed of furniture grade plywood. Step-by-step instructions are provided to make this kit easy to assemble even by one with no experience.

COMPLETE TOOL SET

A clear illustration of just how easy Heathkit building is. The pliers, diagonal sidecutters, two screw drivers and soldering iron are all the basic tools you need for building practically any Heathkit. Pliers and sidecutters are equipped with insulated rubber handles. The American Beauty soldering iron has a replaceable tip to facilitate cleaning. All the tools are of top quality case hardened steel for rugged duty and long life. With these simple, inexpensive tools in your hand you need not be afraid to tackle the most elaborate kit. The manual included with this handy kit provides you with many useful tips on the use and care of your tools. It shows the all important step of making proper solder connections. A truly worthwhile investment for the beginner in electronic kit building. Shpg. Wt. 3 lbs.

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Plan Your Hi-Fi System...

AVAILABLE AFTER JUNE 30

HEATHKIT SP-2 **$56.95**

Model SP-1 (monaural) $37.95

Model C-SP-1 (converts SP-1 to SP-2) $21.95

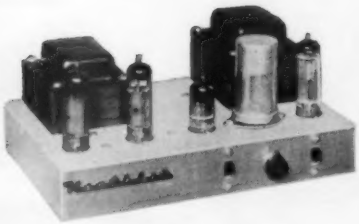
Control both stereo channels simply and conveniently

MONAURAL-STEREO PREAMPLIFIER KIT

This expertly designed preamplifier provides all the controls required for either standard monaural (single channel) or stereo (dual channel) sound reproduction. Features building block design . . . you can start with a basic preamplifier and add a second channel for stereo later on, without rewiring. Second channel plugs in for fast conversion. The complete model SP-2 (stereo) features twelve separate inputs, six on each channel with input level controls. Six dual-concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch (separate on-off switch). The function switch provides settings for stereo, two-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. Tape input has NARTB equalization and input selector provides for RIAA, LP, 78 record compensation. EF86 tubes are used in the input stages along with hum balance controls to assure low hum and noise. Two cathode follower outputs with level controls provided in addition to two separate tape outputs for stereo recording. A remote balance control with twenty feet of cable allows balancing the stereo system from listening position. Construction is greatly simplified through the use of two printed circuit boards (one in each channel) and encapsulated printed circuits. The beautiful vinyl clad steel cover has leather texture in black with inlaid gold design. Built-in power supply.

HEATHKIT WA-P2 **$19.75**

Finger-tip controls for your operating convenience



HEATHKIT UA-1 **$21.95**

A low cost versatile performer

"MASTER CONTROL" PREAMPLIFIER KIT

Designed as a control center for basic amplifiers the WA-P2 provides you with true high fidelity performance for the finest audio systems. Five switch-selected inputs accommodate a record changer, tape recorder, AM-FM tuner, TV receiver, microphone, etc., each with level control. Provision is also made for a tape recorder output. Ideal for "remote" installations, the WA-P2 features a low impedance cathode-follower output circuit allowing greater length of output lead. Full frequency response is obtained within ±1½ db from 15 to 35,000 CPS and will do full justice to the finest available program sources. Equalization is provided for records through separate turnover and rolloff switches for LP, RIAA, AES, and early 78's. A special hum balance control allows setting for minimum hum level. Power for operation is required from basic amplifier or external source. Shpg. Wt. 7 lbs.

"UNIVERSAL" 12-WATT AMPLIFIER KIT

A true high fidelity performer in every sense of the word, the UA-1 makes an ideal basic amplifier for any hi-fi system and is a perfect addition to gear your present hi-fi system for stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range (20 to 20,000 CPS) at full 12 watt output. The on-off switch is located right on the chassis and an octal socket is provided for connecting a preamplifier for remote control operation. The specially designed output transformer provides excellent stability and frequency response. Taps for 4, 8 and 16 ohm speakers, with switched damping for "unity" or "maximum" on the 16-ohm tap. An input level control is provided for use in wired music systems where a preamplifier is not required. This versatile unit is the latest addition to the fine line of Heathkit basic amplifiers. Shpg. Wt. 13 lbs.

With Flexible Heathkit Components

HEATHKIT

DELUXE AM-FM TUNER KIT

Outstanding features in both styling and circuitry are combined in this 16-tube deluxe AM-FM combination tuner to bring you the very finest in program sources, for your listening enjoyment. Features include three circuit boards for easy construction and high stability—prewired, prealigned FM front end—built-in AM rod antenna—tuning meter—AFC (automatic frequency control) with on-off switch and flywheel tuning. AM and FM circuits are separate and individually tuned making it ideal for stereo applications. Cathode follower outputs with individual controls are provided for both AM and FM. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. The unique IF limiter design automatically provides the number of limiting and IF stages required for smooth non-flutter reception. The silicon diode power supply is extremely conservatively rated and is fuse protected assuring long service life. A tuning meter shows when the station is tuned-in for clearest reception on AM or FM. Use of three circuit boards greatly simplifies construction of circuit, you do only a minimum of wiring. All IF transformers and coils are prealigned so it will be ready to operate as soon as construction is completed. Appearance of this top-quality unit is further enhanced by the vinyl-clad steel cover in black with inlaid gold design. A multiplex jack is provided for addition of converter unit to receive multiplex stereo broadcasts on FM. A top dollar value.

AVAILABLE AFTER JUNE 30

HEATHKIT PT-1 **$89.95**

A deluxe AM-FM tuner combination loaded with extras!

HEATHKIT BC-1A **$25.95**

Wide range broadcast reception

HEATHKIT FM-3A **$25.95**

Enjoy static-free FM entertainment

HIGH FIDELITY AM TUNER KIT

This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuit features broad bandwidth to assure low signal distortion. Audio response is ±1 db from 20 CPS to 9 kc, with 5 db of pre-emphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent and the tuner covers the entire broadcast band from 550 to 1600 kc. Quiet performance is assured by a 6 db signal-to-noise ratio at 2.5 uv. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide rule dial for easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

HIGH FIDELITY FM TUNER KIT

FM programming, your least expensive source of high fidelity will provide you with years of real enjoyment. This beautifully styled FM tuner features broad-banded circuits for full fidelity and better than 10 uv sensitivity for 20 db of quieting to pull in stations with clarity and full volume. Covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warmup. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit, making special alignment equipment unnecessary. Edge-lighted glass slide rule dial for easy tuning. You need not wait to have FM in your home at this low price. Shpg. Wt. 8 lbs.

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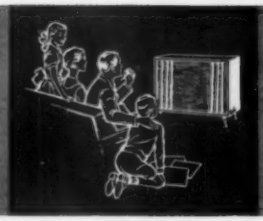


You can be sure you're buying High Fidelity

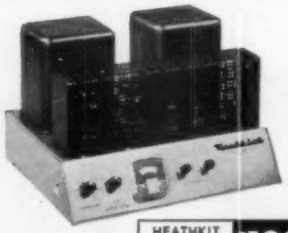
HEATHKIT W-7M **$54.95**

55 watts of hi-fi power at only $1 per watt

★ BEAUTIFULLY STYLED IN BLACK AND GOLD
★ UNITY OR MAXIMUM DAMPING

"EXTRA PERFORMANCE" 55 WATT HI-FI AMPLIFIER KIT

Another Heathkit first! An honestly rated high power amplifier with many top quality features at less than a dollar per watt. Full audio output is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Unique paired output connections permit instant switch selection of "unity" or "maximum" damping factors for all 4, 8 or 16 ohm speakers. Each output has an optimized current feedback circuit for unity damping so that there will be no compromise in performance when any of the impedances is used. This current feedback circuitry is entirely shorted out when not in use to obtain the highest possible damping factor. Features include level control and "on-off" switch right on the chassis plus provision for remote control from preamp, etc. Famous "bas-bal" circuit conveniently balances EL-34 output tubes. These heavy duty push-pull tubes operate into a high quality tapped-screen transformer designed especially for this unit. A 70-volt output on the transformer provides for P.A. or large music systems. The silicon diode power supply features a protection device that controls current until tubes have warmed up, greatly increasing service life of all components. The stylish black and gold case measures 6" H. x 8½" D. x 15" W. Convenient pilot light on the chassis. Thoughtful circuit layout makes this kit easy to build. Dollar for watt you can't beat this buy. Shipped express only. Shpg. Wt. 28 lbs.



HEATHKIT W-6M **$109.95**

Plenty of Reserve Power Without Distortion

"HEAVY DUTY" 70-WATT HI-FI AMPLIFIER KIT

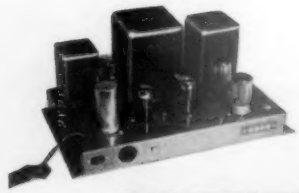
Here is an amplifier that will provide the extra "push" needed to drive any of the fine speaker systems available today, for truly fine performance at any power level. Silicon-diode rectifiers are used to assure long life and a heavy duty transformer gives you extremely good power supply regulation. Variable damping control provides optimum performance with any speaker system. Quick change plug selects 4, 8 and 16 ohms or 70 volt output and the correct feedback resistance. Frequency response at 1 watt is from 5 CPS to 80 kc with controlled HF rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 CPS and IM distortion is below 1%, 60 and 6,000 CPS. Hum and noise 88 db below full output. Metered balance circuit. Designed especially for easy assembly and years of dependable service. Shipped express only. Shpg. Wt. 52 lbs.

HEATHKIT W-5M **$59.75**

Top-Flight Performance for the Critical Listener

25-WATT HI-FI AMPLIFIER KIT

Considered top value in its power class by leading independent research organizations, the W-5M incorporates all the design features required by the super critical listener. Features include a specially designed Peerless output transformer and KT66 tubes. The circuit is rated at 25 watts and will follow instantaneous power peaks of a full orchestra up to 42 watts. A "tweeter saver" suppresses high frequency oscillation and a new type balancing circuit facilitates adjustment of the "dynamic" balance between output tubes. Frequency response is ±1 db from 5 CPS to 160,000 CPS at 1 watt and within 2 db from 20 to 20,000 CPS at full 25 watts output. Harmonic distortion is less than 1% at 25 watts and IM distortion is 1% at 20 watts (60 and 3,000 CPS, 4:1). Hum and noise are 99 db below 25 watts for truly quiet performance. Rich black and gold colored styling. Shipped express only. Shpg. Wt. 31 lbs.



HEATHKIT W4-AM **$39.75**

Faithful Sound Reproduction with Minimum Investment

20-WATT HI-FI AMPLIFIER KIT

This fine amplifier will amaze you with its outstanding performance. It features a true Williamson circuit with extended frequency response, low distortion, and low hum levels. Enjoy true hi-fi with only a minimum investment compared to other units on the market. 5881 tubes and a special Chicago-Standard output transformer are employed to give you full fidelity at minimum cost. Frequency response extends from 10 CPS to 100 kc within ±1 db at 1 watt assuring you of full coverage of the audio range. Clean, clear sound amplification takes place in circuits that hold harmonic distortion at 1.5% and IM distortion below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps on the output transformer are at 4, 8 or 16 ohms to match the speaker system of your choice. An outstanding performer, this investment will bring you years of listening enjoyment. Shipped express only. Shpg. Wt. 18 lbs.

All basic amplifiers recommended for use with model WA-P2, SP-1 or SP-2 preamplifiers

...When You Buy Heathkits

HEATHKIT

"BOOKSHELF" 12-WATT AMPLIFIER KIT

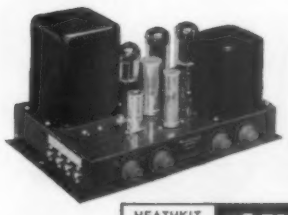
The model EA-2 combines eye-pleasing style and color with many extra features for high quality sound reproduction. This fine amplifier provides full range frequency response from 20 to 20,000 CPS within ±1 db. Harmonic distortion is less than 1% at full 12 watt output over the entire range (20-20,000 CPS). IM distortion is less than 1.5% at 12 watts with low hum and noise. Miniature tubes are used throughout the advanced circuitry, including EL84 output tubes in a push-pull tapped-screen output circuit using a special designed output transformer. Transformer has taps at 4, 8 and 16 ohms. The model EA-2 has its own built-in preamplifier with provision for three separate inputs, mag phono, crystal phono and tuner. The mag phono input features RIAA equalization. Separate bass and treble controls are provided with boost and cut action. A special hum-balance control assures quiet operation. The luxury styled cabinet has a smooth simulated leather texture in black with inlaid gold design and is constructed of vinyl plastic bonded to steel. It resists scuffing, wear, abrasion, and chemicals. The front panel features brushed-gold trim and buff knobs with gold inserts for a very pleasing appearance. An amber neon pilot lamp indicates when the amplifier is on. Cabinet measures 12½" W. x 3 3/16" D. x 4⅜" H. making it suitable for use on a bookshelf, end table, etc. High quality is emphasized throughout for performance matching amplifiers costing many times more. Shpg. Wt. 15 lbs.

HEATHKIT EA-2 **$27.95**

Combines beauty, style and quality

★ LESS THAN 1% DISTORTION AT FULL OUTPUT OVER ENTIRE AUDIO RANGE.

★ BUILT-IN PREAMPLIFIER



HEATHKIT A9-C **$35.50**

A Bargain Package of Power and Performance

HEATHKIT AV-3 **$29.95**

Invaluable for Hi-Fi Testing

HEATHKIT AW-1 **$29.50**

Measure Exact Power Output

GENERAL-PURPOSE 20-WATT AMPLIFIER KIT

The A9-C combines a preamplifier, main amplifier and power supply all on one chassis providing a compact unit to fill the need for a good high fidelity amplifier with a moderate cash investment. Designed primarily for home installations, it is also capable of fulfilling P.A. requirements. The preamplifier section features four separate switch selected inputs. Separate bass and treble tone controls offer 15 db boost and cut. A true high fidelity performer, the A9-C covers 20 to 20,000 CPS within ±1 db. Front panel is detachable, and can be installed on the outside of a cabinet where the chassis comes through, for custom installations. A fine unit with which to start your hi-fi system. Shpg. Wt. 23 lbs.

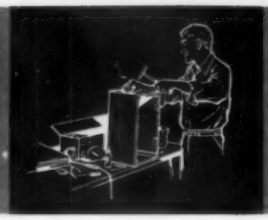
AUDIO VTVM KIT

Critical AC voltage measurements are made easy with this high quality vacuum tube voltmeter which emphasizes stability, broad frequency response and sensitivity. Features large 4½" 200 microampere meter, with increased damping in the meter circuit for stability in low frequency tests. Extremely high voltage range handles measurements from a low value of 1 millivolt to a maximum of 300 volts. AC (RMS) voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover −52 to +52 db. Employs 1% precision multiplier resistors for maximum accuracy. High input impedance (1 megohm at 1,000 CPS). Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

AUDIO WATTMETER KIT

Here is a fine meter to accurately measure output wattage. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w and 50 w full scale. Five switch selected db ranges cover −10 db to +30 db. All indications are read directly on the large 4½" 200 ua meter. Frequency response is ±1 db from 10 CPS to 250 kc. External or internal load resistors are selected with convenient front panel switch. Non-inductive load resistors are built in for 4, 8, 16 or 600 ohms impedance. Precision multiplier resistors are used for high accuracy and incorporates a crystal diode bridge for wide-range frequency response. Modern styling and convenient front panel design. Cabinet is ventilated to allow efficient cooling of load resistors. Shpg. Wt. 7 lbs.

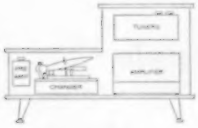
HEATH COMPANY • a subsidiary of Daystrom, Inc. • **Benton Harbor 20, Mich.**



Easy to Buy - Easy to Build - Easy to Use...

HEATHKIT
CE-1
$43.95 each

CONTEMPORARY
Model CE-1B Birch
Model CE-1M Mahogany



TRADITIONAL
Model CE-1T Mahogany

Combine all your Hi-Fi equipment in this attractive cabinet

CHAIRSIDE ENCLOSURE KIT

This Chairside Enclosure lets you combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house the AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit into the space provided. Adequate room is available in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. The enclosure is flexible enough to give you a large choice in component installation. If only one tuner and the preamplifier are used, the two units can be installed in the tilt-out drawer, or if more convenient, either unit can be placed in the space provided in front of the changer compartment. The tilt-out shelf can be installed on either right or left side and the lift-top lid is similarly designed to lift from either side depending on your choice during construction. Good ventilation is achieved through appropriately placed slots in the bottom and back of the enclosure. Overall dimensions are 18"W. x 24" H. x 35½" D. The changer compartment measures 17¾" L. x 16" W. x 9⅝" D. All parts are precut and predrilled for easy assembly and attractive hardware is supplied to match each style. The contemporary cabinet is available in either mahogany or birch and the traditional cabinet is available in mahogany only. Furniture grade plywood can be finished to your taste. Shpg. Wt. 46 lbs.

HEATHKIT **AG-9A** **$34.50**

Your own source of Hi-Fi audio signals

HEATHKIT **AA-1** **$49.95**

3 Audio test instruments in one compact unit

HEATHKIT **HD-1** **$49.50**

Check amplifier distortion quickly

AUDIO SIGNAL GENERATOR KIT

The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals from 10 CPS to 100 kc. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0-.003, .01, .03, .1, .3, 1, 3 and 10 volts RMS. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 CPS. Shpg. Wt. 8 lbs.

AUDIO ANALYZER KIT

Complete high fidelity testing facilities are yours in the AA-1. It combines the functions of three separate instruments; an AC VTVM, audio wattmeter and a complete IM analyzer with filters and high and low frequency oscillators built in. VTVM ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Db scale reads from −65 to +52 dbm. Wattmeter ranges are: .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100% full scale. Provides internal load resistors of 4, 8, 16 or 600 ohms. Combining and consolidating functions reduces the number of test leads and controls required for the same test. Complete instructions are provided for easy assembly, also valuable information on use of instrument. Shpg. Wt. 13 lbs.

HARMONIC DISTORTION METER KIT

Valuable in both designing and servicing of audio circuits, the HD-1 used with an audio signal generator, will accurately measure harmonic distortion at any or all frequencies between 20 and 20,000 CPS. Distortion is read on panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Full scale voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio is measured on a separate meter scale calibrated in db. Features high input impedance (300,000 ohms) and 1% precision resistors in the VTVM voltage divider circuit for excellent sensitivity and accuracy. High quality components insure years of dependable service. Complete instructions provided for easy assembly and operation. Shpg. Wt. 13 lbs.

Heathkits are Your Best Dollar Value

HEATHKIT

TRANSISTOR PORTABLE RADIO KIT

The overwhelming sales of this outstanding transistor portable have made a substantial price reduction possible . . . in addition, an all new plastic molded case adds the finishing touch to the exceptional circuitry. Six name-brand (Texas Instrument) transistors are used for extra good sensitivity and selectivity. The 4" x 6" PM speaker with heavy magnet provides excellent tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of construction. Transformers are prealigned so it is ready for service as soon as construction is completed. A touchup in alignment is easily accomplished on a station by following simple instructions in manual. Alignment tool furnished. Has built-in rod-type antenna for reception in all locations. Six standard size "D" flashlight cells are used for extremely long battery life (between 500 and 1000 hours) and they can be purchased almost anywhere. Cabinet is two-tone blue molded plastic with pull-out carrying handle. Dimensions are 9½" L. x 7¼" H. x 4" D. Shpg. Wt. 6 lbs.

Model XR-1-L: Identical to XR-1-P except in genuine leather case. Rich, warm sun-tan tone. Leather carrying strap included. Shpg. Wt. 7 lbs.

Leather Case: can be purchased separately if desired. Fits all XR-1P's and XR-1's. No. 93-1. Shpg. Wt. 3 lbs. $6.95.

MODEL XR-1-L
$34.95

HEATHKIT **XR-1-P** **$29.95**

Newly designed plastic case . . . new low price!

★ 4" X 6" SPEAKER FOR "BIG SET" TONE
★ LONG BATTERY LIFE (500 to 1000 Hours)

HEATHKIT **CT-1** **$7.95**

Test condensers right in the circuit

HEATHKIT **DF-1** **$54.95**

Pin-point your exact location

HEATHKIT **FD-1** **$35.95** each
(6 volt model FD-1-6)
(12 volt model FD-1-12)

Detects gas fumes

HEATHKIT **MC-1** **$42.95**

Save your boat batteries

IN-CIRCUIT CAPACI-TESTER KIT

Check most capacitors for "open" or "short" right in the circuit with this handy kit. Detects open capacitors from about 50 mmf up, not shunted by an excessively low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage nor check electrolytic condensers.) Employs a 60-cycle frequency for the short test and a 19 megacycle frequency for the open test. Uses electron beam "eye" tube for quick indication. Test leads included. Shpg. Wt. 5 lbs.

TRANSISTOR RADIO DIRECTION FINDER KIT

This transistor radio compass will double as a portable radio. Covers the standard broadcast band from 540 to 1600 kc. Ideal for use aboard boats and also on land by hunters, hikers, etc. A directional high-Q ferrite antenna rotates from the front panel to obtain a fix on a station. A 1 ma meter serves as null and tuning indicator. Prealigned IF transformers—six transistor circuit. Powered by tiny 9-volt battery with spare included. Dimensions 7½" W. x 5⅜" H. x 5⅛" D. Shpg. Wt. 5 lbs.

FUEL VAPOR DETECTOR KIT

Protect your boat and passengers against fire and explosion with one of these fuel vapor detector kits. Indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot lamp shows when the detector is operating. Easy to build and install, even by one not having previous experience. Operates from your boat battery. The kit is complete with heavy-duty neoprene insulated cable and includes spare detector unit. Shpg. Wt. 4 lbs.

MARINE CONVERTER KIT

Charge 6 or 12 volt batteries with this marine converter and battery charger. A panel mounted 25 ampere meter continuously monitors the charging current. Moisture and fungus proofed for rugged marine use. Convection cooling prevents unsafe temperature rise. The MC-1 has no moving parts, tubes nor blowers to wear out or break. Mounting brackets are supplied for easy installation on any boat. Ideal for keeping batteries fully charged or to supply extra current for appliances, Shpg. Wt. 16 lbs.

HEATH COMPANY • a subsidiary of Daystrom, Inc. • **Benton Harbor 20, Mich.**

New Styling - New Features...

HEATHKIT TX-1 **$229.50**

Complete Versatility for Top-Notch Amateur Communications

★ NEWLY DESIGNED VFO—ROTATING SLIDE RULE DIAL
★ MODERN STYLING—PROVISION FOR SSB ADAPTER

"APACHE" HAM TRANSMITTER KIT

Fresh out of the Heath Company laboratories, the brand-new "Apache" model TX-1 ham transmitter features modern styling and the latest in circuitry for extra fine performance. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. These SSB adapters will be available in the near future. A compact, stable and completely redesigned VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters. (11M with crystal control). This unit also has adjustable low level speech clipping and a low distortion modulator stage employing two of the new 6CA7/EL-34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. Shpg. Wt. 115 lbs.

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

HEATHKIT DX-20 **$35.95**

An Ideal Code Transmitter

HEATHKIT DX-100 **$189.50**

You'll be Proud to Own This Outstanding Performer

HEATHKIT DX-40 **$64.95**

Phone & CW Facilities at Low Cost

DX-20 CW TRANSMITTER KIT

Designed especially for CW work, the DX-20 features high efficiency at low cost. An ideal rig for the novice or advanced-class CW operator. Plate power input is 50 watts, and covers 80, 40, 20, 15, 11 and 10 meters with single knob bandswitching. Features a single 6DQ6A tube in the final amplifier stage and a 6CL6 as a crystal oscillator. Pi network output circuit matches various antenna impedances between 50 and 1000 ohms and reduces harmonic output. Top-quality parts are featured throughout, including "potted" transformers, etc., for long service life. Complete shielding to minimize TVI. Removable metal pull-out plug on left end of cabinet provides access for crystal changing. Very easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

DX-100 PHONE AND CW TRANSMITTER KIT

Well known for its high quality and fine performance the DX-100 features a built-in VFO, modulator, and power supply, complete shielding to minimize TVI, and a pi network coupling to match impedances from 50 to 600 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW, for clean strong signals on all ham bands from 10 to 160 meters. Single knob bandswitching and illuminated VFO dial and meter face add real operating convenience. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. High quality components are used throughout, such as potted transformers, silver-plated or solid coin silver switch terminals, aluminum-heat dissipating caps on the final tubes, copper plated chassis, etc. Shpg. Wt. 107 lbs.

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

DX-40 PHONE AND CW TRANSMITTER KIT

An outstanding buy in its power class the DX-40 provides both phone and CW operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 75 watt plate power input on CW, or controlled carrier modulation peaks up to 60 watts for phone operation. Modulator and power supplies are built in and single-knob bandswitching is combined with the pi network output circuit for complete operating convenience. Complete shielding to minimize TVI. Provision is made for three crystals. A four-position switch selects any of the three crystals or a jack for external VFO. Crystal sockets are reached through access door in rear of cabinet. High quality D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.

For Real Ham Enjoyment

HEATHKIT

"MOHAWK" HAM RECEIVER KIT

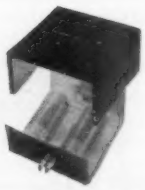
Here is a ham receiver that any radio operator would be proud to own. The "Mohawk" has all the functions required for high quality communications with clear, rock-steady reception on all bands. This 15-tube receiver features double conversion with IF's at 1682 kc and 50 kc and covers all of the amateur frequencies from 160 through 10 meters on seven bands with an extra band calibrated to cover 6 and 2 meters using a converter. Receiver accommodations are provided for these converters which will be available in Heathkits soon. The "Mohawk" is specially designed for single-sideband reception with crystal controlled oscillators for upper and lower sideband selection. A completely preassembled, wired and aligned front end coil assembly assures ease of construction and top performance of the finished unit. Other features include five selectivity positions from 5 kc to 500 CPS, bridged T-notch filter for maximum heterodyne rejection, and a built-in 100 kc crystal calibrator. The set provides a 10 db signal-to-noise ratio at less than 1 microvolt input. Front panel features S meter, separate RF, IF and AF gain controls, T-notch tuning, T-notch depth, ANL, AVC, BFO, bandswitch, tuning, antenna trimmer, calibrate set, calibrate on, CW-SSB-AM, receive-standby, upper-lower sideband, selectivity, phone jack and a wide band rotating slide rule type vernier tuning dial with easy to read calibrations. Shpg. Wt. 90 lbs.

$50.00 required on C.O.D. orders. Shipped motor freight unless otherwise specified.

HEATHKIT RX-1 **$274.95**

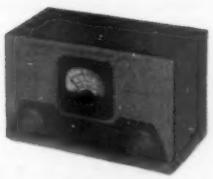
Now in Kit Form a Top Quality Ham Band Receiver

★ PREWIRED AND ALIGNED FRONT END COIL ASSEMBLY.
★ CRYSTAL CONTROLLED OSCILLATORS FOR DRIFT-FREE RECEPTION.



HEATHKIT B-1 **$8.95**

Get Proper Match Between Transmitter and Antenna

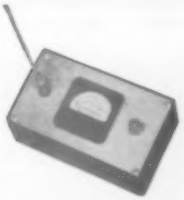


HEATHKIT AM-2 **$15.95**

Measure Standing Wave Ratio

HEATHKIT VX-1 **$23.95**

Eliminates Hand Switching



HEATHKIT PM-1 **$14.95**

Quick Check of Transmitter Operation

BALUN COIL KIT

Unbalanced coax lines used on the most modern transmitters can be matched to balance lines of either 75 or 300 ohms impedance by using the model B-1 Balun Coil Kit. Can be used with transmitters and receivers without adjustment over the frequency range of 80 through 10 meters, and will handle power inputs up to 200 watts. Cabinet size is 10" square by 5" D. and may be located any distance from the transmitter or antenna. A protective cover is supplied to prevent damage in outdoor installations. Shpg. Wt. 4 lbs.

REFLECTED POWER METER KIT

The match of your antenna transmission system can be checked by measuring the forward and reflected power or standing wave ratio from 1:1 to 6:1 with this fine unit. Designed to handle a peak power of well over 1 kilowatt of energy the AM-2 may be left in the antenna system feed line at all times. Band coverage is 160 meters through 2 meters. Input and output impedances for 50 or 75 ohm lines. No external power required for operation. Cabinet size is 7⅛" x 4⅛" x 4⅜". Shpg. Wt. 3 lbs.

ELECTRONIC VOICE CONTROL KIT

This unique device allows you to switch from receiver to transmitter merely by talking into your microphone . . . you get the advantage of "telephone-type conversation" as in single sideband but with regular AM transmission. The unit is adjustable to all conditions by sensitivity controls provided. A variable time delay control changes the "hold" time. Provision is made for receiver and speaker connections and also for a 117 volt antenna relay. Built-in power supply. Complete instructions provided. Shpg. Wt. 5 lbs.

RF POWER METER KIT

This self contained unit requires no power for operation. You simply place it close to the transmitter antenna to sample the RF field which is then indicated on the panel meter. Operates with any transmitter having an output frequency between 100 kc and 250 mc, regardless of power. Sensitivity is 0.3 volts RMS full scale, and a special control on the panel allows for further adjustment of the sensitivity. Measures 3¼" W. x 6¼" L. x 2" D. An easy way to put your mind at ease concerning transmitter operation. Shpg. Wt. 2 lbs.

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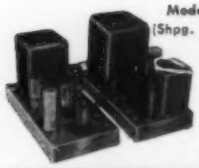
Choose from a wide variety of Heathkits

DUAL-CHASSIS 20 WATT HI-FI AMPLIFIER KIT

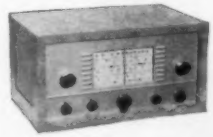


Model W3-AM
(Shpg. Wt. 29 lbs.)
$49.75

12" UTILITY SPEAKER

Model 401-6
(Shpg. Wt. 7 lbs.)
$7.50

ALL-BAND RADIO KIT



Model AR-3
(Shpg. Wt. 12 lbs.)
$29.95
(less cabinet)

CRYSTAL RADIO KIT

Model CR-1
(Shpg. Wt. 3 lbs.)
$7.95

BROADCAST BAND RADIO KIT

Model BR-2
(Shpg. Wt. 10 lbs.)
$18.95
(less cabinet)

ELECTRONIC CROSSOVER KIT

Model XO-1
(Shpg. Wt. 6 lbs.)
$18.95

"Q" MULTIPLIER KIT

Model QF-1
(Shpg. Wt. 3 lbs.)
$9.95

"AUTOMATIC" CONELRAD ALARM KIT

Model CA-1
(Shpg. Wt. 4 lbs.)
$13.95

GRID DIP METER KIT

Model GD-1B
(Shpg. Wt. 4 lbs.)
$21.95

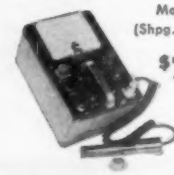
VIBRATOR POWER SUPPLY KIT

6 volt Model VP-1-6
12 volt Model VP-1-12
(Shpg. Wt. 4 lbs.)
$7.95 ea.

VARIABLE FREQUENCY OSCILLATOR KIT

Model VF-1
(Shpg. Wt. 7 lbs.)
$19.50

PROFESSIONAL RADIATION COUNTER KIT



Model RC-1
(Shpg. Wt. 8 lbs.)
$79.95

ISOLATION TRANSFORMER KIT

Model IT-1
(Shpg. Wt. 9 lbs.)
$16.50

ELECTRONIC SWITCH KIT

Model S-3
(Shpg. Wt. 8 lbs.)
$21.95

REGULATED POWER SUPPLY KIT

Model PS-3
(Shpg. Wt. 17 lbs.)
$35.50

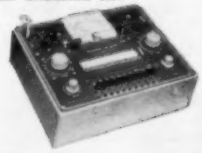
VOLTAGE CALIBRATOR KIT

Model VC-3
(Shpg. Wt. 4 lbs.)
$12.50

DIRECT-READING CAPACITY METER KIT

Model CM-1
(Shpg. Wt. 7 lbs.)
$29.50

TUBE CHECKER KIT



Model TC-2
(Shpg. Wt. 12 lbs.)
$29.50

EASY TIME PAYMENTS

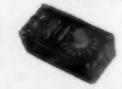
AVAILABLE FOR YOUR CONVENIENCE . . .

Any order totaling $90 or more can be paid for in small monthly payments (send for complete details).

RESISTANCE SUBSTITUTION BOX KIT

Model RS-1
(Shpg. Wt. 2 lbs.)
$5.50

CONDENSER SUBSTITUTION BOX KIT



Model CS-1
(Shpg. Wt. 2 lbs.)
$5.50

CATHODE RAY TUBE CHECKER KIT

Model CC-1
(Shpg. Wt. 10 lbs.)
$24.95

LABORATORY RF GENERATOR KIT

Model LG-1
(Shpg. Wt. 16 lbs.)
$48.95

"Q" METER KIT

Model QM-1
(Shpg. Wt. 14 lbs.)
$44.50

DECADE CONDENSER KIT

Model DC-1
(Shpg. Wt. 3 lbs.)
$16.50

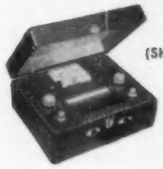
DECADE RESISTANCE KIT

Model DR-1
(Shpg. Wt. 4 lbs.)
$19.50

...to Fill Your Exact Needs

HEATHKIT

PORTABLE TUBE CHECKER KIT

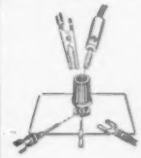


Model TC-2P
(Shpg. Wt. 15 lbs.)
$34.50

TV PICTURE TUBE TEST ADAPTER* FOR TC-2 AND TC-2P

Model 355
(Shpg. Wt. 1 lb.)
$4.50

BINDING POST KIT



Model 362
(Shpg. Wt. 1 lb.)
$4.00

BATTERY TESTER KIT

Model BT-1
(Shpg. Wt. 2 lbs.)
$8.50

ELECTRONIC IGNITION ANALYZER KIT

MODEL IA-1
(Shpg. Wt. 20 lbs.)
$59.95

SCOPE PROBES

Scope Demodulator Probe Kit
Model 337-C
(Shpg. Wt. 1 lb.)
$3.50

Low Capacity Probe Kit
Model 342
(Shpg. Wt. 1 lb.)
$3.50

VTVM PROBES

30,000 Volt DC HV
Probe Kit No. 336
Shpg. Wt. 2 lbs. $4.50

Etched Circuit RF
Probe Kit No. 309-C
Shpg. Wt. 1 lb. $3.50

Peak-to-peak Voltage
Probe Kit No. 338-C
Shpg. Wt. 2 lbs. $5.50

ENLARGER TIMER KIT

Model ET-1
(Shpg. Wt. 3 lbs.)
$11.50

IMPEDANCE BRIDGE KIT

Model IB-2A
(Shpg. Wt. 12 lbs.)
$59.50

"LOW RIPPLE" BATTERY ELIMINATOR KIT

Model BE-5
(Shpg. Wt. 21 lbs.)
$39.95

ELECTRONIC ANALOG COMPUTER KIT
Full Computer Group C
$945.00

Write for free folder.

Free Catalog

Send for this informative booklet describing these and many other do-it-yourself kits.

ORDER DIRECT BY MAIL . . . from the WORLD'S LARGEST MANUFACTURER

OF ELECTRONIC INSTRUMENTS IN KIT FORM

Save ½ or more over equivalent ready-made products by buying direct and assembling them yourself. You gain priceless knowledge through complete and informative construction manuals.

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ORDER BLANK

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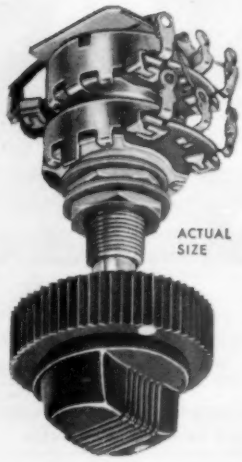

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TELEVISION

(*Continued from page* 61)

frequencies. More will be said concerning F2 television reception in the November FM-TV Dx column. (See "Looking In on London," page 52, this issue.)

Report forms

During the past few months, the TV Dx column has received numerous letters, "I read about TV and FM dx in your column, and thought that I would give it a try. Much to my surprise, I logged . . ." Undoubtedly, many readers are keeping a half-cocked eye on the FM or TV scene for some signs of distant reception, although not considering themselves full-fledged dxers. In FM and TV dx reception, it is not quantity, but quality which counts.

In short, we would like to have a report from you, no matter how small or seemingly insignificant. Write for a set of report forms today, and get into the swing of dx reporting. Simply address a postcard to RADIO-ELECTRONICS, TV Dx Column, 154 W. 14 St., New York 11, N.Y. with your name and address firmly and clearly on the back. END

Defective Socket

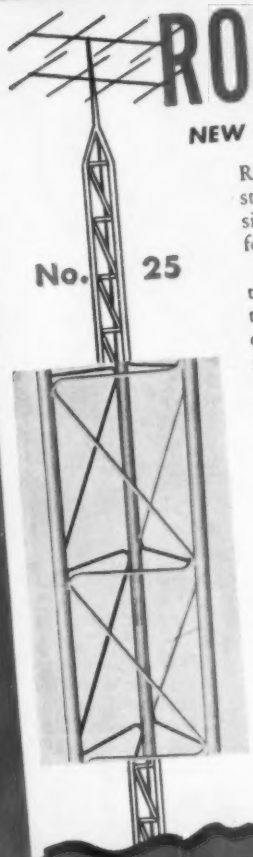
One evening I was called to repair a Trav-Ler which had no picture. The first tube replaced was a 6SN7 horizontal oscillator and the picture immediately returned. Satisfied the trouble was located, I made the customary checks and departed. In approximately a week this customer reported the picture was again gone. I replaced the same 6SN7 and the picture returned.

The customer was assured that even new tubes sometimes are defective and again I departed confident the trouble was remedied. Within two weeks the customer reported that by turning the set on and leaving it on for an hour or so it would eventually have a picture. For the third time I replaced the 6SN7. This time I pushed the tube down into the socket and watched it. A few seconds later it popped up! I pushed the tube well down into the socket at least five times, and each time it eased back up. This accounted for the delayed operation, for eventually due to vibration the tube lost contact as it rested on top of the socket. I've seen many loose tube sockets, but these were simply repulsive.
—*P. J. Hogan*

"What do you charge to install an antenna on a steep roof?"

ROHN Designs Amazing No. 25 Tower to reach new heights in tower engineering

NEW GENERAL-PURPOSE COMMUNICATION OR HEAVY-DUTY TV TOWER



ROHN now offers a tower a full 33% stronger and more durable than similar sized and similar type towers that are found on the market today!

These amazing results are achieved through using **heavier-duty** side rail tubing, **quality** steel that is of the highest grade and a new "zig-zag" cross bracing design.

The strength of this tower allows it to be self-supporting under most conditions to 50′ and under guyed conditions up to 150′. The tower has been built to fit a tremendously wide range of needs in communications, amateur use and as a heavy-duty TV tower.

FLASH! The "RohnKote" enameling plant is in operation and ROHN products are available not only in **HOT-DIPPED GALVANIZING** but also in a specially developed 6-step enameling process known as "RohnKote".

NOW! 10 Different Lines of ROHN TOWERS, Including:

No. 6

Widely used for home TV, this tower features "magic triangle" cross bracing construction.

Packaged Towers in which the sections nestle inside each other.

No. 40

Heavy-duty communications tower suitable self-supporting at heights up to 60′ or guyed as high as 300′. Ideal for communications uses of all types, microwave, radio telephone, etc.

No. 20 & 30

Heavy-duty communications towers in RohnKote enamel.

Fold-Over Towers

Ideal for amateurs and experimenters inasmuch as the tower folds over for convenient antenna changing, etc. Supplied in both medium and heavy-duty sizes to handle practically any size beam.

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ROHN masts are outstanding in design and have special features that make them the best in the field and in addition, are as low or lower in cost than any other.

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ROHN Manufacturing Company

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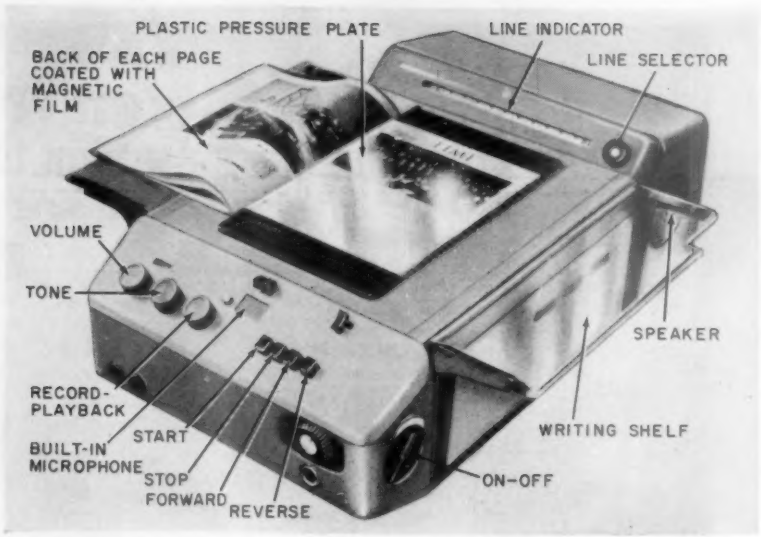
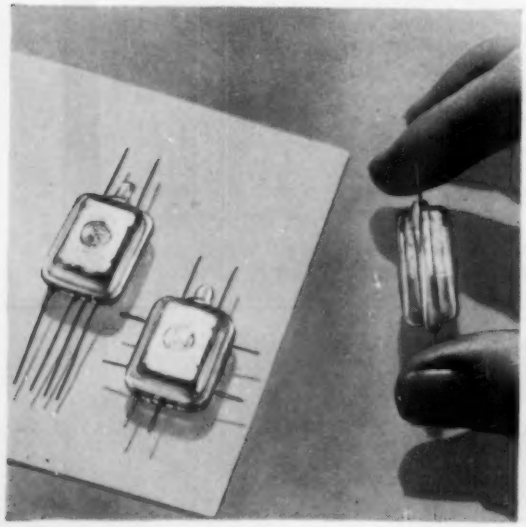
what's new?



MAGNETIC PAGE RECORDER-READER works like a tape recorder, except that the record–playback heads move instead of the recorded material. Developed by Prof. Yasushi Hoshino of Tokyo Institute of Technology, the Synchroreader accommodates page-sized sheets of paper, coated on one side with an iron oxide material. The other side can contain written or printed matter. Each sheet is scanned by three revolving heads on a traveling turntable, moving from left to right and top to bottom. The page recordings can be fully scanned or selected portions located and played. The manufacturer, Canon Camera Co. of Tokyo, suggests the device can be used to read "talking magazines" (as above) or letters. A Japanese trade publication speculates: "Supposing you get a letter from your sweetheart, you can listen to her voice while you are reading the letter."

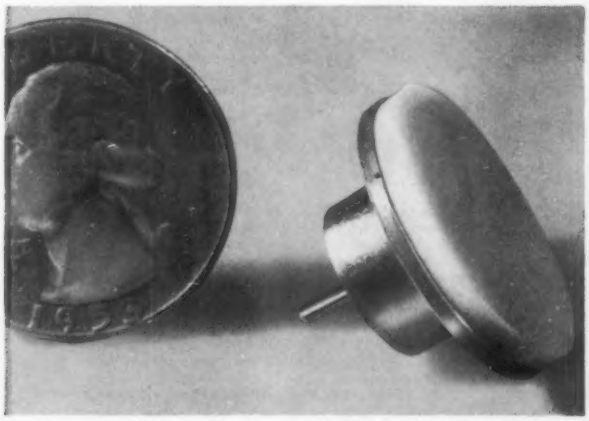
BIGGEST OVAL SPEAKER is this 9 x 21-inch unit shown with 4-inch, 4 x 6-inch and 8-inch speakers often found in today's TV receivers. It is used in new General Electric television sets. The big oval works in conjunction with the 4-inch tweeter (held in hand) to reproduce 40 to 10,000 cycles.

NEW SHAPE IN TUBES, the "matchbox" envelope, has been developed for military use by Westinghouse Electric Corporation. Since it uses the same electrode structure as conventional receiving tubes, the design can be applied to an entire line of tubes. Made of Pyroceram heat-resistant ceramic, its advantages are dimensional accuracy, elimination of possibility of loose particles and gas, adaptability to recessing or strapping to printed-circuit boards and high resistance to vibration.

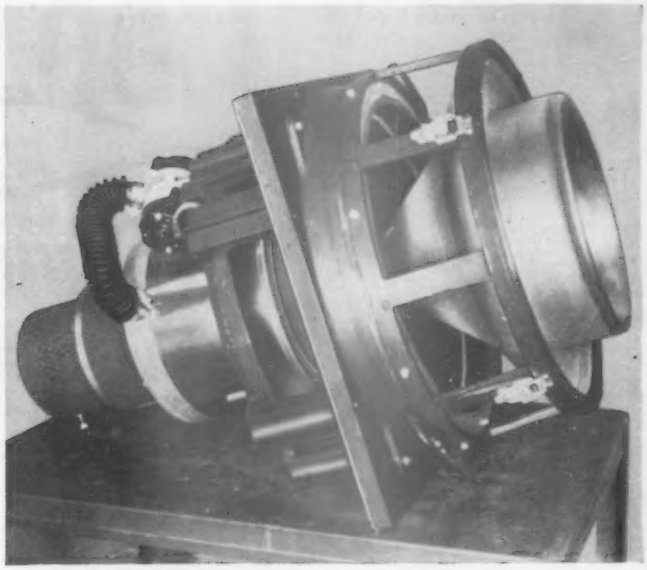


NOW IT'S 8 1/3 RPM – but not for home music systems. This is a laboratory model of a new "talking-book" phonograph for the blind developed by Dr. Peter Goldmark of CBS Laboratories for the Library of Congress, which plans to replace the 45,000 33⅓-rpm talking-book phonos now in use with the new speed within a few years. Since its frequency range is only 100–5,000 cycles, Dr. Goldmark sees no general commercial applications for the 8⅓-rpm records. Their principal advantage is economy: a 7-inch disc will play for 2 hours on each side, costing one-tenth the amount of the equivalent material on 33⅓-rpm records and saving $300,000 a year in shipping costs alone.

PERCHING THE TUBE ATOP THE SET seems to be the new trend in avant-garde television receiver design. This set, a Teleavia console made by Societe Francaise Frigeavia, Paris, uses the same bold approach to TV design as the American and Italian tube-atop-set models shown on page 77 in last month's Radio-Electronics. In this model, the tube assembly may be swiveled 180°, and tilted upward or downward by means of the adjustment knob below the tube housing. The top of the tube housing and the top rear panel of the chassis housing are removable for servicing.



KEY TO ATOMIC POWER may be held by the tiny high-vacuum thermionic converter developed by scientists of the General Electric Research Laboratory. A combination of metal and ceramic discs surrounding a vacuum, this working model produces electricity directly from heat. Although voltage and current produced by this model are low, G-E scientists estimate that converters this size will be capable of operating in the 1–10-watt range. In such a converter, two electrodes are held at high, but different temperatures. Electrons are "boiled out" of the hotter cathode and are collected by the relatively cool anode. An earlier thermionic converter, a foot-long gas-filled tube, was announced by G-E last year.



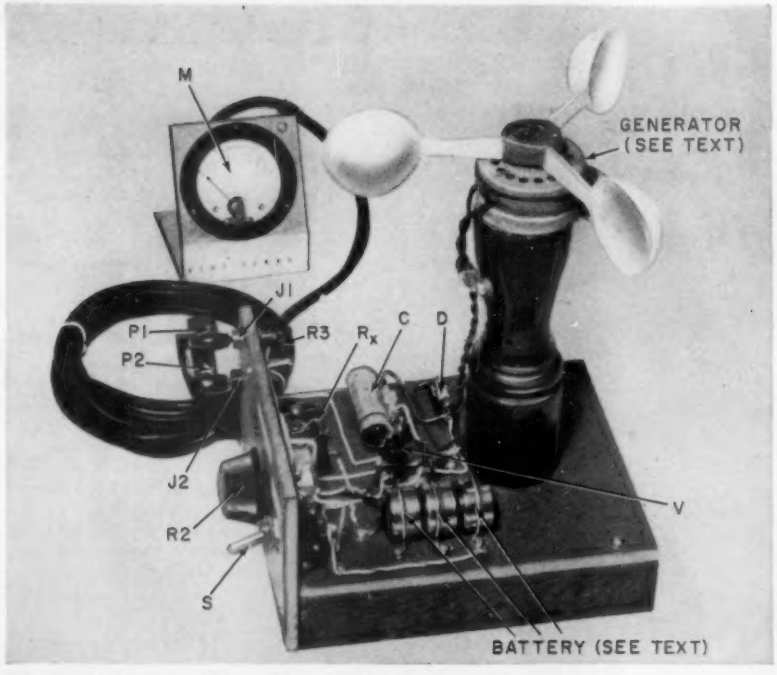
WANT LOTS OF VOLUME? Try this 1,000-watter in your hi fi. Actually, this 150-pound speaker was built by Stromberg-Carlson for the Convair acoustical laboratory's research into the effects of high-intensity noise on missiles and jet planes. Its woofer is driven by a 24½-pound Alnico V ring magnet with a total air-gap flux of 696,000 maxwells, and produces sounds up to 300 cycles. The cone vibrates as much as 2 inches. Because of its high power dissipation, the voice coil is cooled by a powerful fan. An acoustic compression driver and coaxial horn supply sounds from 300 to 2,400 cycles. Though they won't be used in the Convair installation, Stromberg-Carlson has designed a ring of 13 tweeters to surround the mid-range horn and extend the range to 15,000 cycles.

MORE SENSITIVE THAN THE EYE, 100 times more sensitive to light than the fastest photographic film for the same exposure time at low light-level, this Intensifier Orthicon, which can "see" in surroundings which appear totally dark, may find important uses in astronomy, military reconnaissance and scientific research. Developed by Dr. George A. Morton (left) and Dr. John E. Ruedy of RCA's David Sarnoff Research Center, the developmental tube is based on the Image Orthicon TV camera tube, but permits viewing of TV-like images of scenes with light levels from 100 to 1,000 times below those required by an Image Orthicon. Inside the tube is an "intensifier screen" which emits 10–20 electrons for every one that strikes it. With two such screens, about 300 electrons are produced for every one released by the image on the tube's sensitive surface.

an ELECTRONIC ANEMOMETER

By IRVING M. GOTTLIEB

A clock motor, transistor dc amplifier, and milliammeter are the principal parts of this simple wind-speed indicator



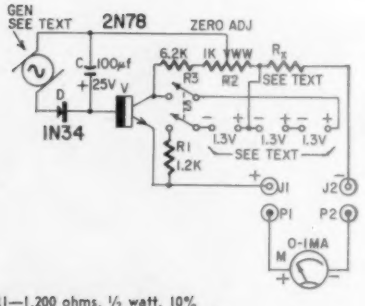
The finished unit with remote speed indicator. Note that the wind cups are mounted well clear of the chassis.

FOR a number of hobbies and activities, a way to measure wind speed is useful. The wind-speed indicator described here can be used at model-airplane meets, small airports and boat houses and by amateur meteorologists. It can also be used anywhere wind speed must be monitored—smog and air-pollution investigation, for example.

The indicator unit is made up of an ac generator, an anemometer wind element, a transistor current amplifier and an indicating meter. The operating principle is simple. As shown in Fig. 1, the ac output from the generator is rectified by diode D, and the resulting dc is applied to the base of transistor V. The transistor's output, connected across meter M, gives a reading proportional to the speed of the wind turning the generator. Stronger winds give higher readings.

An electric clock motor is used for the ac generator. I tried several motors and, while there are variations in their outputs, almost any one may be used. As the transistor amplifier provides plenty of gain, even with low-output units, it is best to select the motor with the lowest friction—it will turn at lower wind speeds. Clock motors can often be purchased from surplus houses at very low cost.

After you have selected a motor, connect it to an oscilloscope and manually spin the motor shaft or disc *(not the low-rpm output shaft)*. Spin the motor in both directions and note which



R1—1,200 ohms, ½ watt, 10%
R2—pot, 1,000 ohms, wirewound
R3—6,200 ohms, ½ watt, 10%
C—100 μf, 25 volts
D—1N34
J1, 2—tip jacks
M—0-1 ma, dc meter
P1, 2—tip plugs
S—dpst toggle
V—2N78 (G-E)
Battery, 4-volt mercury (Mallory TR-233R or equivalent) (this battery consists of three series-connected cells)
Generator, electric clock motor (see text)
Plastic tablespoons (3)
Miscellaneous hardware

Fig. 1—Circuit of the easily constructed wind-speed indicator.

generates the highest output. This determines whether a clockwise or counterclockwise wind element is needed. The motor I used turned out to be more efficient when turned counterclockwise.

Assemble the wind cups

The next step is to build the wind cups. These are made of three stiff

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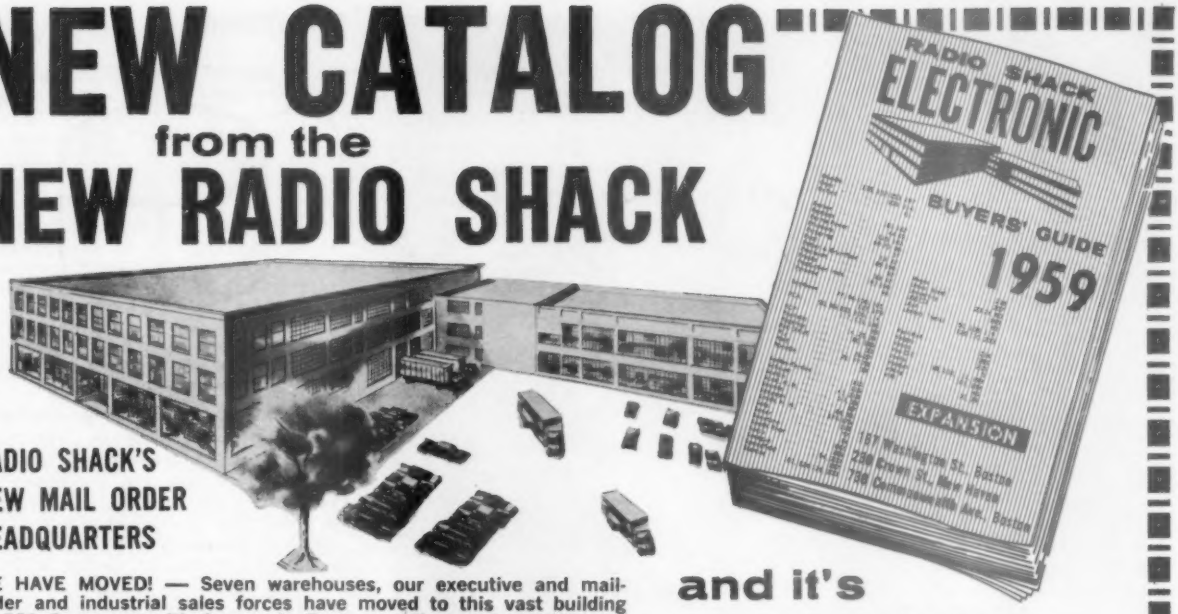

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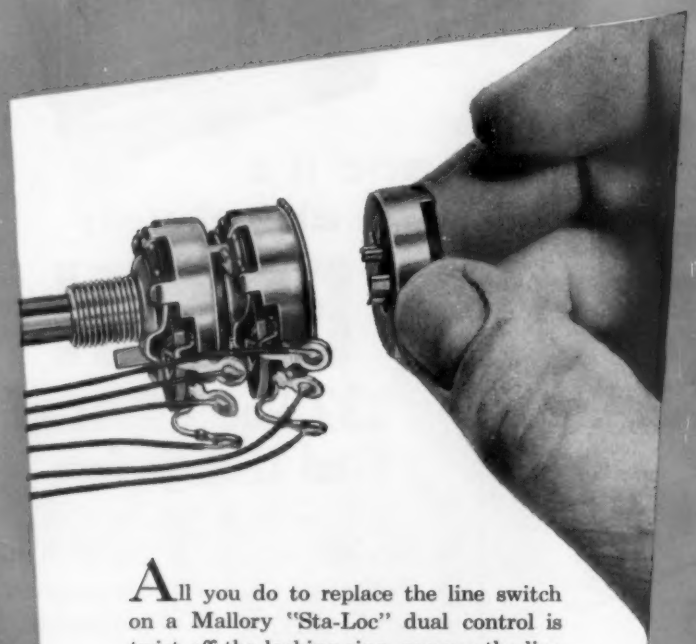

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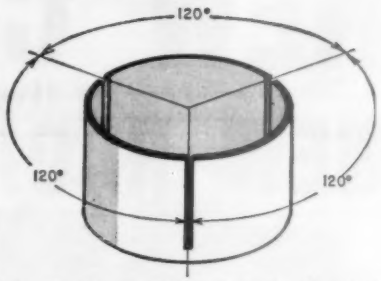

Fig. 2—The bottle-cap hub for the wind cups has three slots spaced 120° apart cut into its side.

plastic tablespoons and a plastic bottle cover (about an inch in diameter). Rubber and soft-plastic spoons are also available, but are not recommended. They flex while in use and introduce the possibility of false readings.

With a hacksaw, cut three slits in the cylindrical wall of the bottle cover. The slits should be spaced 120° apart (see Fig. 2). Measure slot spacing with a protractor.

Using the bottle cover as a hub, fit the spoon handles into the slots and fill the cover with household cement. Use a few blocks of wood to support the spoons until the glue has had a chance to harden. When the glue is partially set, you can make final adjustments in the position of the spoons. *Be sure they are set up to provide the proper rotation for your motor.* Remember, the wind moves the spoons in the direction pointed out by their convex (outer) surfaces. Also note that the convex surface of one spoon looks into the concave surface of the next.

Final adjustment of the spoon handles is simplified by placing the hub on a large sheet of paper which has three radial lines, 120° apart, drawn from some central point. Line the spoons up with these lines. As a large mass of cement is in the hub, allow two days for it to harden properly.

After the cement is solidified, the wind-cup assembly is cemented to the motor disc. Be sure that no cement gets into the motor. The motor with the mounted wind element is fastened on a pedestal 6–12 inches high to gain free access to the wind. [The author's unit was examined after being exposed to the (California) weather for three months, and was in excellent condition. However, the motor is exposed, and in more rugged climates, it might be wiser to use a larger plastic cup or refrigerator container upside down instead of—or under—the plastic cap shown in the photos. This would act as a roof and sidewalls to shield the motor from the elements.]

Diode D, capacitor C, meter M and the mercury battery must all be polarized as in the schematic. Keep in mind that on the mercury battery the button is the *negative* terminal and the case the *positive* terminal. The 4-volt battery is made up of three 1.3-volt cells. Remove the cardboard case from the battery and tap the cells to provide the

type of supply shown. Of course, three separate cells may be used and, if you prefer, you can use 1.5-volt penlight or standard D-size flashlight cells.

Capacitor C provides the filtering needed at low wind speeds. This capacitor, in conjunction with the inertia of the meter movement, keeps deflection steady down to wind speeds of 3 or 4 miles an hour, the minimum that will turn the motor. Resistor R_x sets the sensitivity of the device. Its value depends on the beta gain of the transistor and the wind speed you want for full-scale deflection.

Calibrating the meter

In my model I got a full-scale reading at 30 mph with a 910-ohm resistor for R_x. This was determined by holding the wind-speed indicator out of a car window and checking the meter reading against the speedometer. (Calibrations must be carried out when the wind is quiet, and calibrating runs should be made in at least two directions to average out error caused by air motion.) Of course, the unit can be calibrated against an anemometer at a local weather station or airport. For lower full-scale readings lower values of R_x are used. However, the resistance should be not less than 50 ohms. It provides current feedback to stabilize transistor operation with respect to temperature changes and also improves linearity. With less than 50 ohms a stable zero indication is not possible.

For better stability and linearity, the circuit is designed so that current flows in the emitter–collector circuit even when the generator is stationary. This current is due to the positive bias applied to the transistor's base through the arm of potentiometer R2. The meter deflection which would be caused by this current is counteracted by a local current supplied by the single mercury cell through R1. Therefore, by adjusting R2, a zero setting is obtained when there is no wind. If the zero-adjust point is not within the center range of pot R2, a slight change in the value of R3 will center this point.

Although I intended only to describe an electronic speed indicator, I would like to suggest using the generator, rectifier and filter capacitor to power small transistor radios. While such an application is possible, several points must be considered to get effective results. First, the clock-motor generator delivers a relatively low voltage—in the order of several tenths of a volt. A voltage-multiplying circuit would be better than the simple half-wave rectifier. Also a conventional choke and capacitor filter should be used to smooth ripple at low wind speeds. Finally, some type of voltage regulation, such as attainable with Zener diodes is desirable.

Both the wind-speed indicator and the suggested wind-driven power supply are off-the-beaten-track projects which should provide many interesting hours for the electronics experimenter. END

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TRY THESE PHOTOCELL CIRCUITS

Three ways you can use the sensitive CdS unit

By EDWIN BOHR

SENSATIONAL is the only word to describe the characteristics of the cadmium sulfide (CdS) crystal photocell. Few cells match its sensitivity, ruggedness, long life, small size and low cost.

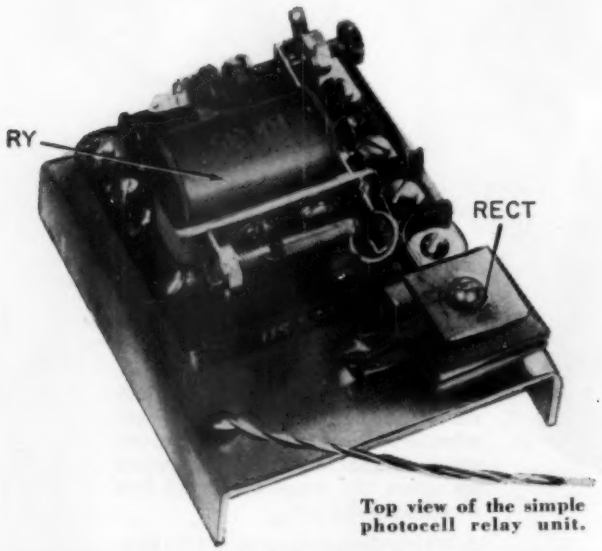
These photocells are *photoconductive* and require somewhat different circuitry than do other types. However, the circuits are simple. In many applications the cell output is enough to operate a sensitive relay without amplification.

Tubeless relay

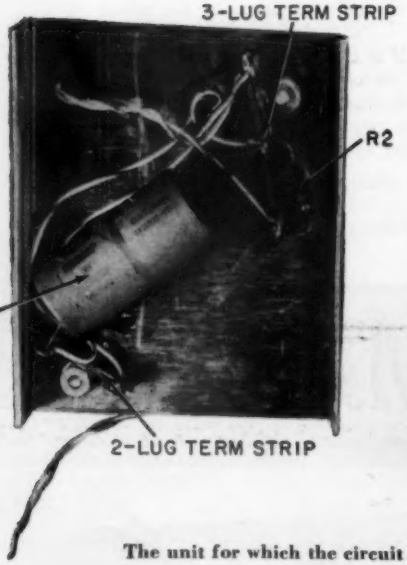
Probably the simplest application of a crystal photocell is shown in Fig. 1. The cell is connected in series with a sensitive relay and dc power supply. Resistor R1 reduces the sensitivity, but protects the cell from excessive current flow at high light levels.

Like any resistor, the cell has a maximum dissipation rating, which depends upon the crystal's ability to get rid of heat. A copper backing plate, used in special cell designs, produces very high dissipation ratings. However, existing cells are rated in milliwatts. For example, the Clairex CL-2 is rated at 50 mw.

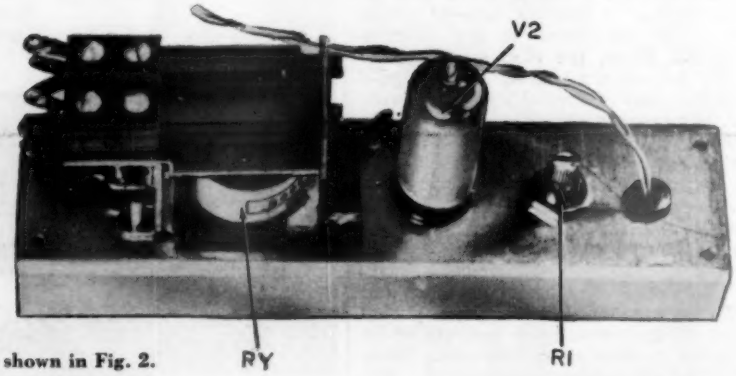
The value of the protective resistance is based on the dissipation rating of the crystal and the voltage developed across it at power match, which is one-half the supply voltage. The formula then is simply $R = (\frac{1}{2}E)^2W$, where E is the supply voltage and the crystal



Top view of the simple photocell relay unit.



Under the chassis. Note the use of terminal strips.



The unit for which the circuit is shown in Fig. 2.

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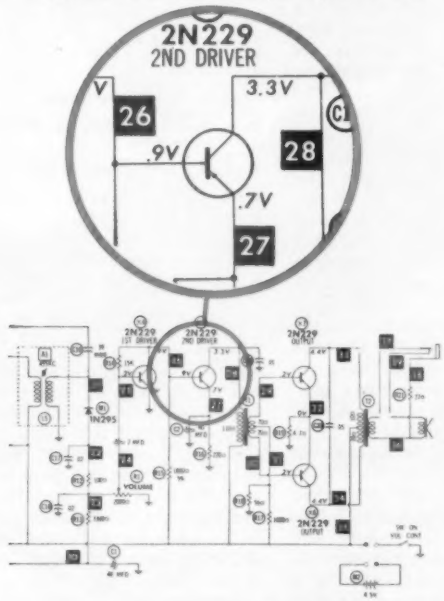

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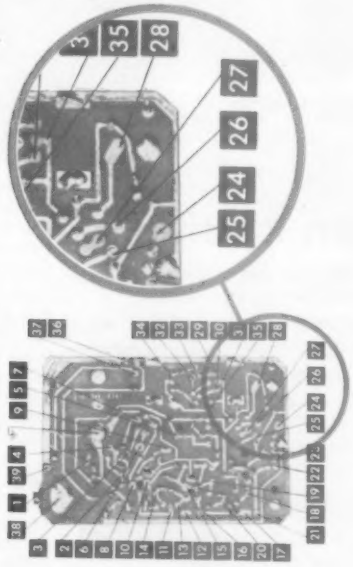

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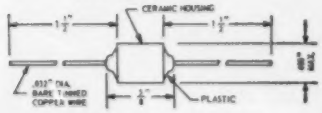
MAX. OPERATING TEMP.	100°C	100°C
MAX. SURGE CURRENT (AMPS)	30	20
MIN. SURGE LIMITING RESIS. (OHMS)	7.5	10

DIMENSIONS



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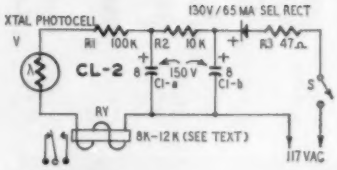


R1—100,000 ohms
R2—10,000 ohms
R3—47 ohms
All resistors ½ watt
C1—8-8 μf, 150 volts, electrolytic
RECT—selenium, 130 volts, 65 ma
RY—8,000-12,000-ohm coil (Sigma 4F-8000, BK-35, Advance 850 or equivalent)
S—spst
V—CL-2 (Clairex or equivalent)
Terminal strip (2 lugs)
Terminal strip (3 lugs)
Chassis, to suit
Miscellaneous hardware

Fig. 1—Simple circuit uses a minimum of parts. R1 is placed in the lead to the photocell and covered with spaghetti, and does not appear in the photo.

rating is W in watts. As a rule of thumb, for the 50-milliwatt crystal, use a minimum of 50,000 ohms per hundred volts of supply. The resistance of the relay coil can, of course, be considered as part of the protective resistance.

Now let's see how the circuit acts with a typical photocell and relay. Using a CL-2 cell, 100,000 ohms for R1, and a relay adjusted to close at 1 ma, less than 1 foot-candle keys the relay.

Any relay that operates on 1 ma is suitable for use with the CL-2. Higher illumination does not yield appreciably greater currents because of the cushioning effect of R1.

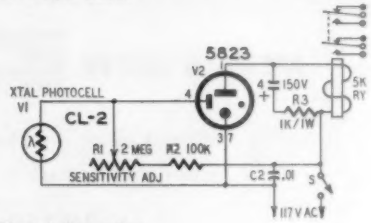
A few suitable relays are the Sigma 4F, BK-35 (surplus) and the Advance 850 with a 10,000-ohm coil. These relays have fairly delicate contacts usually not suitable for operating motors or heavy loads from incandescent lights. But you can use them to operate a power relay.

For running the circuit at higher light levels (and consequently lower cell resistances) simply reduce the supply voltages and circuit resistances. A few minutes experimenting with a milliammeter in place of the relay will indicate the correct values for a given set of light conditions. For this as well as the circuit in Fig. 2, be sure to make all line-return connections to terminal strips isolated from the chassis (see photos). This will prevent hot-chassis possibilities.

Cold-cathode relay

Fig. 2 features a wide span of adjustment and the trigger threshold can be set for high as well as low light levels. The control tube is a miniature seven-pin unit similar in many respects to the older 9A4-G.

Raising the starter-electrode (pin-4) voltage past a critical point initiates a discharge to the cathode that transfers to the anode. The glow discharge is extinguished each time the ac supply goes through zero.



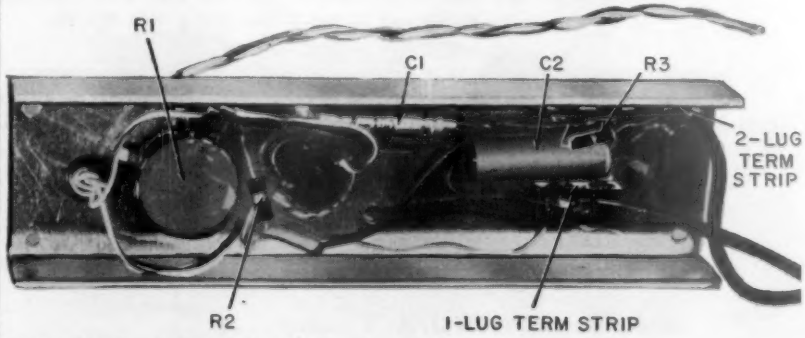
R1—pot, 2 megohms
R2—100,000 ohms
R3—1,000 ohms
All resistors ½ watt
C1—4 μf, 150 volts, electrolytic
C2—.01 μf, 600 volts
RY—5,000-ohm coil (Guardian 200-5000D or equivalent)
S—spst
V1—CL-2 (Clairex or equivalent)
V2—5823
Socket, 7-pin miniature
Chassis, to suit
Miscellaneous hardware

Fig. 2—Use of a cold-cathode tube and a sensitivity control increases the circuit's versatility.

The starter electrode is fed from a voltage divider across the ac line. One leg of this divider contains the CdS cell. A decreasing light level raises the starter electrode to the striking potential, activating the plate relay.

A small electrolytic capacitor (C1) is placed across the relay to smooth the rectified ac and prevent the relay from buzzing. In series with this capacitor is a 1,000-ohm resistor which limits charging current to the 100-ma rating of the 5823.

Almost any 5,000- or 10,000-ohm plate relay is satisfactory for this circuit. The circuit shown in the photograph used a Guardian series 200 relay with a 5,000-ohm plate coil. However, the large magnetic gap and high con-



Underchassis of the cold-cathode relay circuit. Again note the use of terminal strips.

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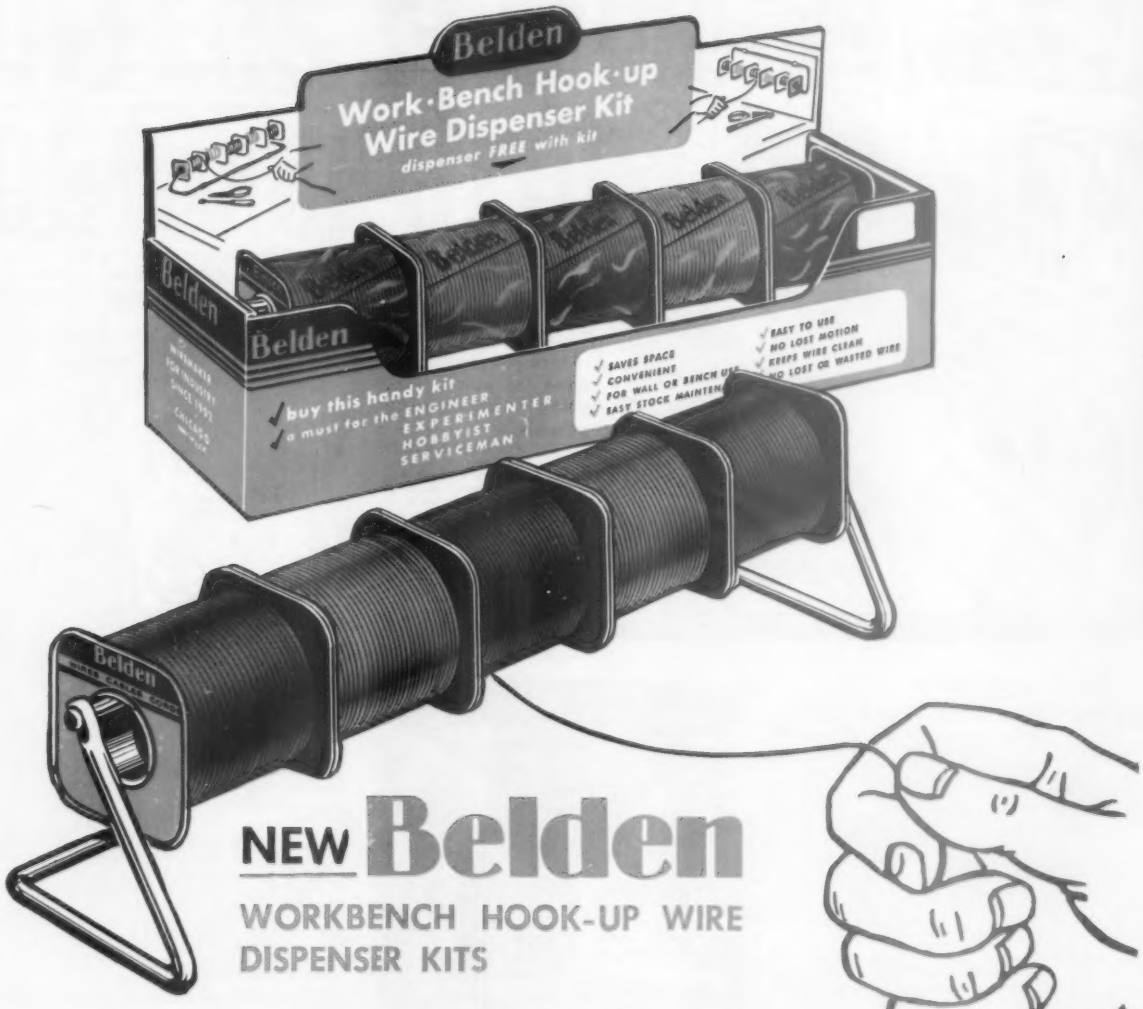

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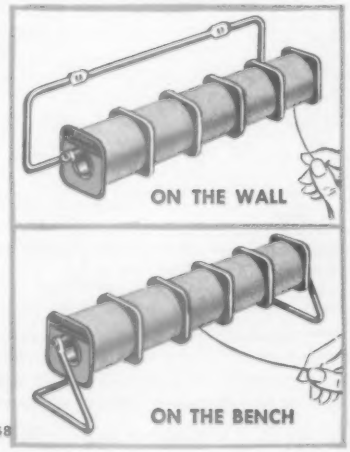

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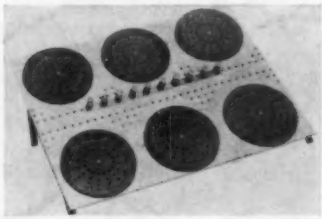

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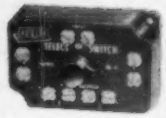

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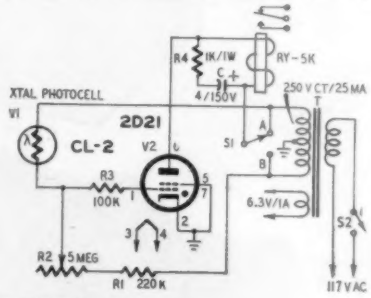
tact pressure of this particular type made it necessary to stretch the contact spring to reduce flutter at marginal operation. Contact assemblies for these relays handle up to 12-amperes per contact—enough for all but the heaviest loads.

The 5823 tube is usually listed as a special-purpose or industrial type and may not be stocked by the local jobber. Nevertheless, it is available from several mail-order houses for about $1.50.

2D21 relay

Unlike the preceding circuits, this one (Fig. 3) is isolated from the power line by a transformer. In principle, except for the differences in tubes, the circuit is similar to Fig. 2 and the same comments apply. It does, however, require heater power and a few extra components.

By changing the connection from A to B (or inserting S1 as shown in Fig. 3), either increasing- or decreasing-



R1—220,000 ohms
R2—pot, 5 megohms
R3—100,000 ohms
R4—1,000 ohms, 1 watt
All resistors ½ watt unless noted
C—4 μf, 150 volts, electrolytic
RY—5,000-ohm coil (Guardian 200-5000D or equivalent)
S1—spdt
S2—spst
T—power transformer: primary, 117 volts; secondary, 250 volts, 25 ma, ct; 6.3 volts, 1 amp (Stancor PS-8416 or equivalent)
V1—CL-2 (Clairex or equivalent)
V2—2D21 (see text)
Socket, 7-pin miniature
Terminal strip (2 lugs)
Terminal strip (1 lug)
Chassis, to suit
Miscellaneous hardware

Fig. 3—Transformer-powered unit can be triggered by an increase or decrease in light.

light operation can be selected. This connection changes the phase of the ac applied to the 2D21's plate.

The smooth operation and isolation from the line lead me to suggest this 2D21 unit as a *universal* relay for the crystal cell. It is suitable for all but the most specialized applications.

Illuminating the cell

The crystal photocell's active area is not too much larger than the period at the end of this sentence. The total amount of light received by a cell without a lens system is very small. However, the great sensitivity of the cell makes a lens or parabolic-reflector light-gathering system unnecessary except for light levels below about a ½ foot-candle. A lens system would be necessary, for example, only for devices such

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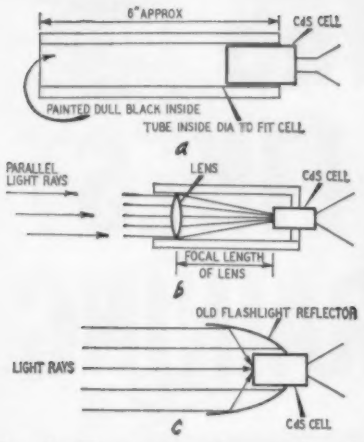


Fig. 4—Three ways of mounting the cell.

as headlight-operated outdoor advertising signs.

Photocell relay circuits operate on a *change* in light intensity. Therefore, if an alarm or signal circuit is to operate during both daylight and darkness, the photocell must be placed in a tube to eliminate stray side lighting, as shown in Fig. 4-a. A similar arrangement with a lens is shown in Fig. 4-b.

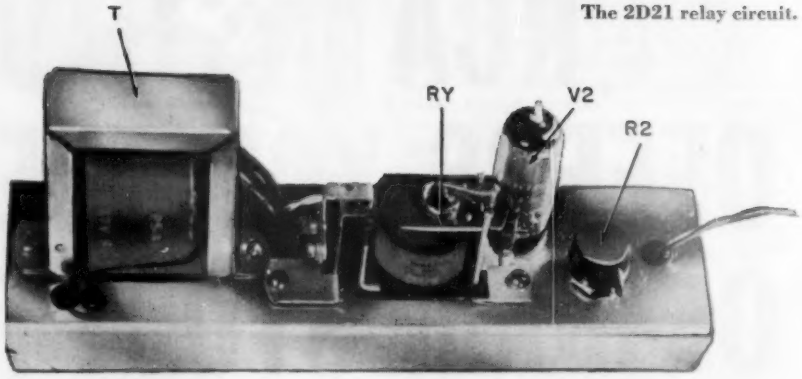
A parabolic reflector from an old flashlight can be used to concentrate light on the crystal (Fig. 4-c). Move the cell around until the reflector focus is found. Even for the best adjustment, some of the light from the reflector will hit the photocell case and not reach the CdS crystal. This limits the practical sensitivity increase to about four times for the flashlight reflector.

Because of the small crystal size, the cell makes an excellent detector of small movements. Suppose a light mask with a hole the size of the crystal is placed immediately in front of the cell. A 1-millimeter movement of the mask would then cut the light completely on or off. A radio dial light would be a satisfactory light source.

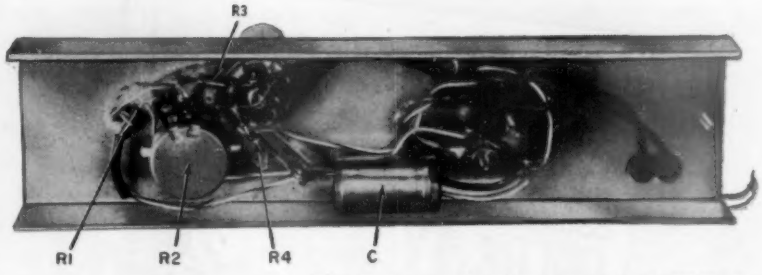
For any application the necessary light-source strength depends upon its distance from the cell. A little experimenting with lights will give the answer but the following examples should give an indication of the sensitivity that can be expected.

Properly adjusted, the circuit of Fig. 3 will operate at night from a two-cell flashlight at a distance of 75 to 100 feet. Fig. 1 opens and closes with the interruption of living-room illumination just sufficient to read by. It makes a good circuit for automatically operating outdoor or house lighting or radio tower lights at sundown.

The CdS cell has one disadvantage that has not been mentioned. It has a time constant—it does not respond instantly to an increase or decrease in light. This time constant is usually about 5 msec. For most applications this time lag is insignificant since the relays are even slower. It does, however, make the cell unsuitable for high-speed time-interval measurements. Also, the time constant results in a high-frequency rolloff in response to modulated light.



The 2D21 relay circuit.



Plenty of room for all parts under the 2D21 chassis.

A cadmium sulfide (CdS) crystal photocell.

Circuit sensitivity can be further increased by using a Clairex CL-3. This is a cadmium selenide cell which is extremely sensitive in the red and near infra-red region of the visible spectrum.

END

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By RUFUS P. TURNER

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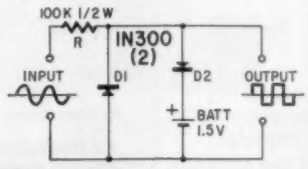

This circuit (see diagram) is somewhat simpler and considerably better than earlier ones. The superior front-to-back resistance ratio of the silicon-junction diodes used in this model improves clipper performance at low signal levels. Furthermore, because of the very low reverse current of the silicon-junction diode (much less than 1/1,000 microampere at 1.5 volts!), no on-off switch is needed.

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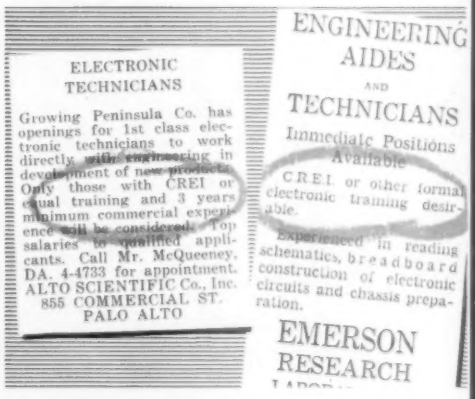

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How's Your Scientific Knowledge?

By RUDOLF F. GRAF

MANY scientists have made invaluable contributions in the audio and electronic field. Some of their names have been perpetuated by physical phenomena or quantities named after them, while others have made their contribution and their names have gone into obscurity.

Test your knowledge of these 20 men, without whom radio, radar, television, hi fi and many other present-day miracles would not be possible. Match their names with one of their better known scientific discoveries or quantities or phenomena to which their names have been linked.

If you know them all, our hat's off to you. A score of 17 to 19 correct is very good indeed and 14 to 16 is about average. Simply write the letter found in the lower part of column after the numeral preceding the name of the man who made that particular discovery.

Answers are on page 135.

The men

1 ..... André M. Ampère
2 ..... Anders J. Angstrom
3 ..... Alexander G. Bell
4 ..... Lee de Forest
5 ..... Christian Doppler
6 ..... Thomas A. Edison
7 ..... Michael Faraday
8 ..... Harvey Fletcher
9 ..... Jean B. J. Fourier
10 ..... Karl F. Gauss
11 ..... William Gilbert
12 ..... Joseph Henry
13 ..... Gustav R. Kirchhoff
14 ..... Joseph J. Thomson
15 ..... H. F. Emil Lenz
16 ..... Guglielmo Marconi
17 ..... Wilhelm K. Roentgen
18 ..... Wallace C. Sabine
19 ..... Allessandro Volta
20 ..... Vladimir K. Zworykin

Their accomplishments

A Wave analysis
B Network theories
C Capacitance
D First practical wireless
E Magnetomotive force
F Potential difference
G Light wavelength
H Flux density
I Frequency change
J Electron
K Current
L Iconoscope
M Inductance
N Triode
O Sound measurement
P Sound recording
Q Current-flux relationship
R Telephone
S X-ray
T Sound range

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✓ Checks for inter-element shorts and leakage.
✓ Checks for gas content.
✓ Checks for life-expectancy.

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Sync-circuit Subber

Speed servicing of those tricky sync circuits. Substitute known good circuits to find the bad one in the receiver

By W. G. ESLICK

REPAIRING TV receiver sync circuits is easier said than done. To find out what section of the set is causing horizontal pulling, tearing or jitter—sync clipper, phase detector, or horizontal oscillator—takes a lot of painstaking circuit checking. Vertical roll or unstable vertical oscillators present the same problem—is it the oscillator or the output stage?

To make the job easier, I designed the sync-circuit subber described in this article. Built almost completely from junkbox parts, this unit has provisions for substituting for each of the mentioned circuits and thus determining whether it is or isn't the faulty one. As the unit delivers only about 30 volts peak to peak at the VERT OUT jack, it will not fill the screen on most sets. But this doesn't matter, all we really want to know is if the vertical is clean on the TV set—no roll or distortion. The HORIZ OUT jack delivers 200 volts, husky enough for all purposes.

No special layout was followed, but keep the vertical and horizontal outputs away from the sync circuits—you don't want any heavy pulses in the inputs.

With switches S1, S2 and S3 down, the circuits they control—phase detector, horizontal oscillator, and vertical oscillator—are connected to the appropriate input jacks and are independent of each other. Throwing these switches up interconnects various sections of the subber, thus making it possible to substitute for either one section or a major part of a TV receiver's sweep circuits.

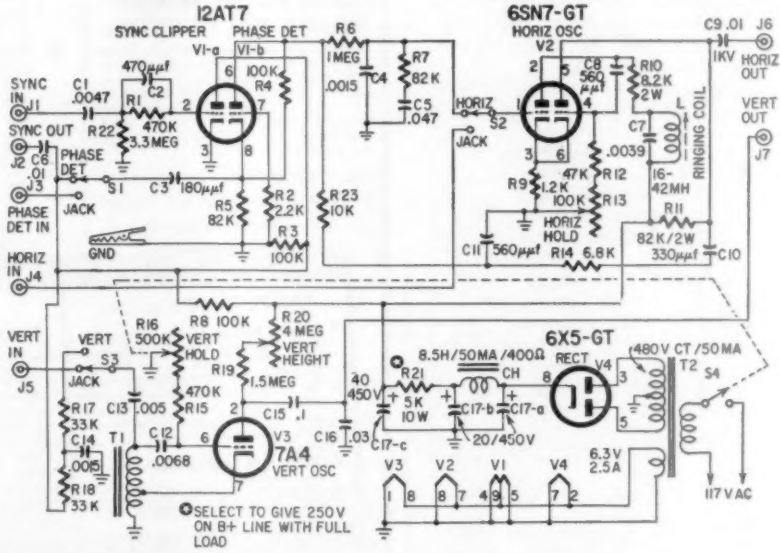
Half of V1 is a sync clipper using positive-going sync pulses in the input. The other half of this tube is a phase detector which corrects the horizontal frequency. A pulse can be fed to the phase detector's cathode from the sync clipper and a sample oscillator voltage pulse to its plate. This plate can be coupled to the horizontal oscillator grid through R6 and S2. When the oscillator is in step, the phase-detector output is zero. This output becomes a negative, or positive voltage, depending on whether the oscillator is running slow or fast, and it corrects the horizontal oscillator frequency.

The horizontal oscillator is a multivibrator without any frills other than the feedback circuit to the phase detector. The multivibrator includes a ringing coil and hold control. The vertical oscillator is a blocking oscillator with a hold control and height adjustment.

The rectifier is a 6X5-GT. I could have used a 6X4, but the chassis had already been punched for larger sockets.

All front-panel jacks are banana types and the cables have banana plugs on one end and alligator clips on the other. The ground lead is connected directly to the subber's ground and an alligator clip is attached to its loose end.

A 12AU7 can be used instead of the



Sync-circuit subber is built from junkbox parts.

R1, 15—470,000 ohms
R2—2,200 ohms
R3, 4, 8—100,000 ohms
R5, 7—82,000 ohms
R6—1 megohms
R9—1,200 ohms
R10—8,200 ohms, 2 watts
R11—82,000 ohms, 2 watts
R12—47,000 ohms
R13—pot, 100,000 ohms, linear taper
R14—6,800 ohms
R16—pot, 500,000 ohms, linear taper, with spst switch S4
R17, 18—33,000 ohms
R19—1.5 megohms
R20—pot, 4 megohms, linear taper
R21—5,000 ohms, 10 watts, select to give 250 volts on B-plus line with full load
R22—3.3 megohms
R23—10,000 ohms
All resistors ½-watt 10% unless noted
C1—.0047 μf
C2—470 μμf
C3—180 μμf
C4, 14—.0015 μf
C5—.047 μf
C6—.01 μf
C7—.0039 μf
C8, 11—560 μμf
C9—.01 μf, 1,000 volts
C10—330 μμf
C12—.0068 μf
C13—.005 μf
C15—0.1 μf
C16—.03 μf
C17—20-20-40 μf, 450 volts, electrolytic
CH—8.5 henries, 50 ma, 400 ohms
J1, 2, 3, 4, 5, 6, 7—banana jacks
L—ringing coil, 16-42 mh, (G-E RLI-210, Miller 6210 or equivalent)
S1, 2, 3—spdt toggle
S4—spst on R16
T1—vertical blocking oscillator transformer (G-E RTO-192, Triad A-120Z, Stancor A-8126 or equivalent)
T2—power transformer: primary, 117 volts; secondary, 480 volts ct, 50 ma; 6.3 volts, 2.5 amps (Merit P-3147 or equivalent)
V1—12AT7
V2—6SN7-GT
V3—7A4
V4—6X5-GT
Chassis to suit
Miscellaneous hardware

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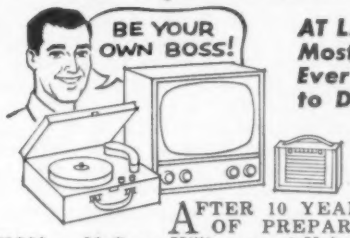

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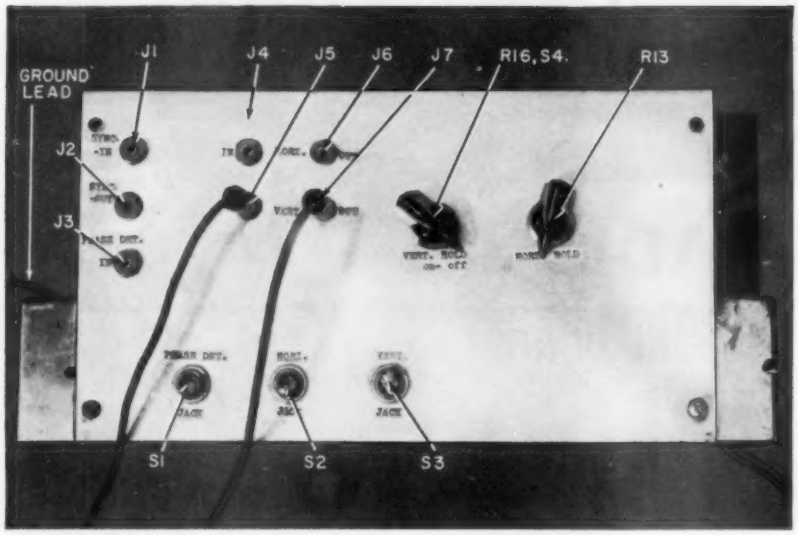
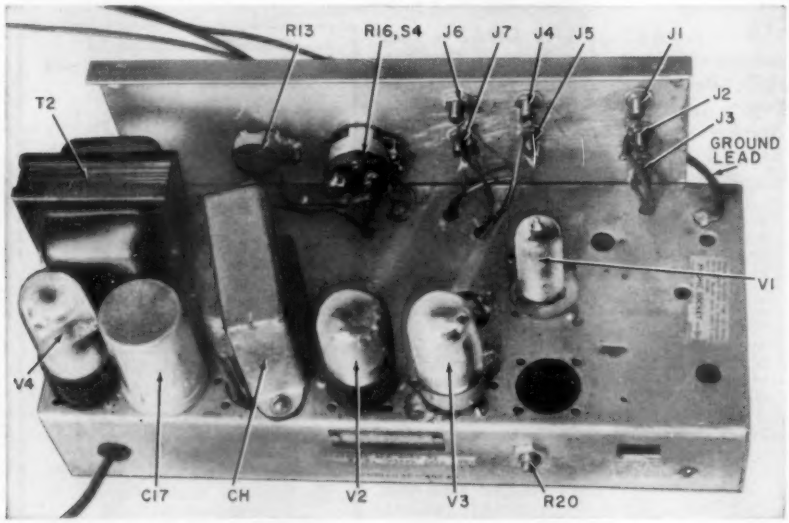
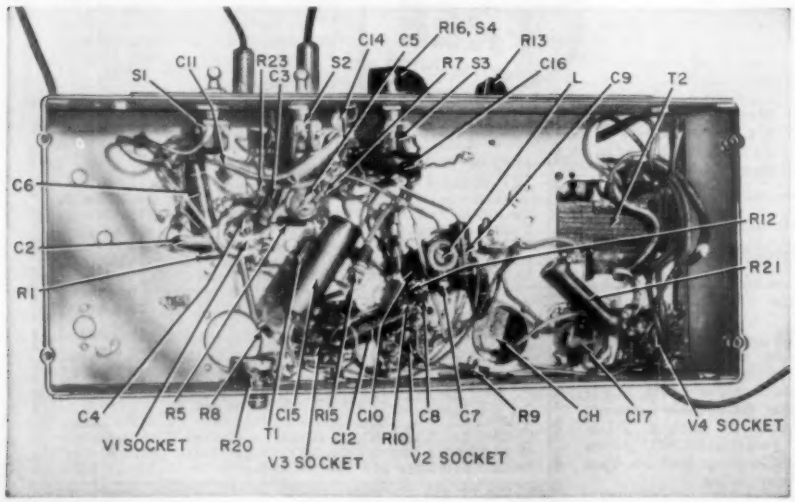


The front panel layout.



An old radio chassis was used for the subber. As you can see (below), the instrument could be made much smaller.



6SN7 if desired and a 6C4, 6J5 or 6C5 for the 7A4, but the values of C12, R19 and R15 may have to be juggled.

Subbing vertical circuits

When puzzled by short or stretched pictures due to some fault in the vertical deflection circuits, disconnect the receiver's vertical output section, leaving only the grid-load resistor to provide a complete grid circuit. Now, connect the subber's VERT OUT to this grid and the subber's ground lead to the TV chassis or common ground circuit.

With the receiver and subber on, adjust the subber's VERT HOLD control until the picture is nearly still. Adjust height as well as possible. There isn't any sync, so the picture will roll slowly, but you can tell if the picture is still short or stretched. If the trouble is still there, you know the output stage is faulty. If the picture returns to normal, look to the vertical oscillator for trouble.

To lock the vertical sync (if deemed necessary) flip switch S3 up to the VERT position. With this switch up, the subber's sync circuit is switched in. Now connect a cable to the SYNC IN jack and touch the other end (with the alligator clip) to the set's video detector. If vertical sync won't lock here, go to the plate of the set's sync amplifier and then try the grid and plate of the sync clipper and also the grid and plate of the phase splitter, if the set has one.

With the SYNC IN cable connected to one of these points, the vertical sync will lock (where we can get a positive-going sync signal). In some sets, the video detector has a negative sync output while others have a positive output. A look at the set's schematic will tell, as most show video and pulse data on the diagram. This also holds true when looking for a spot to use to lock the horizontal sync.

For no vertical deflection (a straight horizontal line across the screen) when your scope shows no drive at the vertical output tube's grid and voltages seem OK, a quick check can be made without unsoldering or cutting any leads. Flip all subber switches down. Using the VERT OUT lead (subber ground connected to the TV set), touch the grid of the receiver's vertical output tube. If this gives you vertical deflection, back up to the vertical oscillator's plate.

If the sweep disappears, look for an open coupling capacitor or a shorted wave-shaping network. If the plate point gives vertical deflection, go to the oscillator's grid. You are interested only in vertical scan on the TV screen, not in how good or bad it is. If you have vertical sweep, you are using both the vertical oscillator and vertical output tubes in the TV set as amplifiers for the subber's oscillator and everything will be out of proportion. But now you know that the trouble is in the transformer or associated components if a blocking oscillator is used, or a

faulty feedback network if the output stage feeds back a small voltage to the input of the first tube.

Now the horizontal circuits

For no horizontal sweep or high voltage, touch the HORIZ OUT lead to the grid of the receiver's horizontal output tube. If sweep and high voltage reappear, we have eliminated the output stage as the trouble spot.

If you have horizontal sweep, but some kind of horizontal trouble exists, disconnect everything but the grid-load resistor on the TV's horizontal output stage and connect the subber's HORIZ OUT to this grid. With switch S2 down (freeing the subber's horizontal oscillator from all other subber circuits), either pull the horizontal oscillator tube from the set or clip all connections from the input side of the first section (usually the grid that goes to some sort of an afc circuit) and connect these leads to the subber's HORIZ IN jack.

Here, you are substituting only for the set's horizontal oscillator and are using the receiver's afc and sync circuits. If the set works properly, the trouble is in the circuit being replaced by the subber—the horizontal oscillator circuit. If you still have trouble, disconnect the subber's HORIZ IN from the TV set, flip switch S2 up to HORIZ and switch S1 down. Now the subber's phase detector is connected to the subber's horizontal oscillator and the phase detector is connected only to the PHASE DET IN jack.

Connect a cable from this jack to the set's sync amplifier plate or grid, or to the sync clipper's grid or plate (or phase splitter grid or plate) till horizontal sync locks (adjusting the subber's HORIZ HOLD control, of course).

One thing to remember: If you go back beyond the clipper to the sync amplifier, there may be enough video present to make the circuit unstable. If you still have trouble or are in doubt, throw switch S1 up and connect the cable to the SYNC IN jack and go from the video detector to the sync amplifier grid or plate till proper polarity pulses are found. Now you have subbed the clipper, phase detector and horizontal oscillator.

A word to the wise: On the TV set's horizontal oscillator grid from afc, there is usually an R-C network called an anti-hunt circuit. Be sure these components are good and have proper grounds.

The sync clipper in the subber can be used by itself. When doing so, disconnect grid and plate leads to this tube in the receiver or pull the tube.

This unit is simply a tester to help speed servicing. It is not 100% perfect, but it has performed well wherever it has been used. It tells you if you do or don't have trouble in a particular stage. Once the trouble is pinned down to a single stage, the repair job is comparatively easy. END

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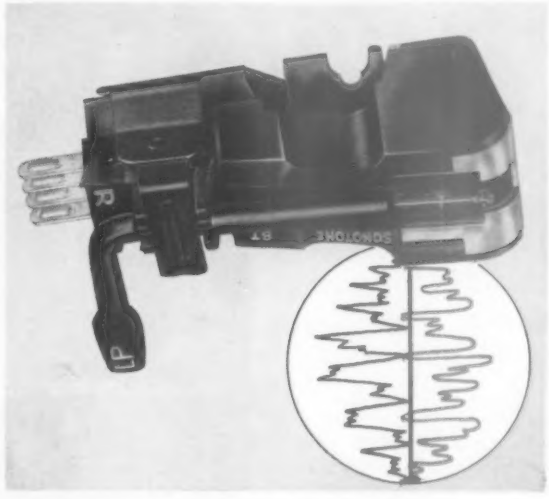

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you can measure PHASE SHIFT

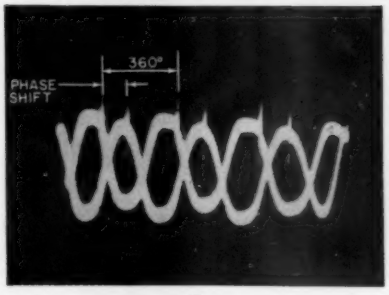
When used in combination with an oscilloscope, a differentiating amplifier makes accurate phase measurements possible

By TOM JASKI

PHASE meters are expensive instruments, and most experimenters cannot afford to invest in one for the infrequent phase measurements they make. So most of us measure phase with an oscilloscope and other available equipment.

However, measuring phase by comparing traces on a scope face is not an easy task, particularly if accuracy is required. We can use an electronic switch, overlap the traces and somehow measure the distance between zero points, using bezel marks as a reference. Or we can show an ellipse on the scope by feeding the original and phase-shifted voltages to the vertical and horizontal amplifiers, and measure phase by scaling the axes of the ellipse. These are familiar methods, which unfortunately are not particularly accurate.

The amplifier described in this article helps make the phase-measuring job easier and more accurate. It takes the original waves, makes sharp spikes out of them and mixes the spikes with the original voltage. This definitely and precisely marks the voltage in time. Thus the task of phase measurement is reduced to measuring the distance between sharply defined spikes and dividing the results. This is shown in Fig. 1. The distance between spikes of adjacent waves of the same phase is a full cycle, or 360°. The distance between spikes on both waves, divided by the distance of spikes on the same wave, is the phase-angle proportion of 360°. Thus, if the first measurement is one-fourth of the second, we have a 90° phase shift. Measuring the spike distances in Fig. 1-a, we find a 103° phase shift. The spikes in Fig. 1-b show an exact 108° shift. This method of using only the spikes has a disadvantage—if the phase shift approaches



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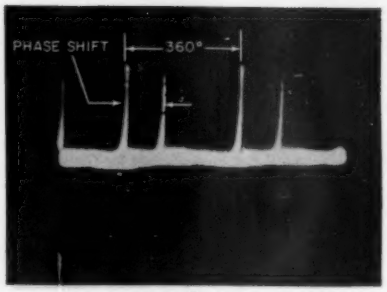

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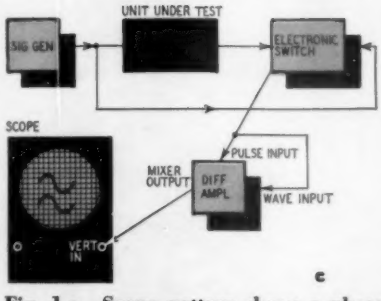
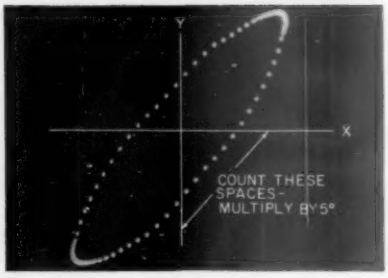


c

Fig. 1-a—Scope pattern shows a phase shift of 103°; b—phase shift of 108°; c—block diagram of setup for this test.



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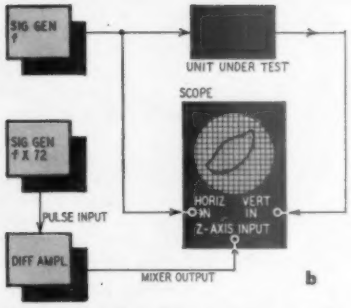

b

Fig. 2-a — Another pattern used to measure phase shift. Each dot represents a 5° phase shift; b—block diagram to obtain this pattern.

180° the pips may be difficult to distinguish as belonging to one voltage or the other.

If we make spikes at exactly 72 times the frequency at which we wish to measure phase shift, and feed these spikes to the grid of our scope cathode-ray tube, we see the pattern of Fig. 2. Here we use the vertical and horizontal amplifiers for the original and shifted voltages, respectively, to display an ellipse, which we then chop into 72

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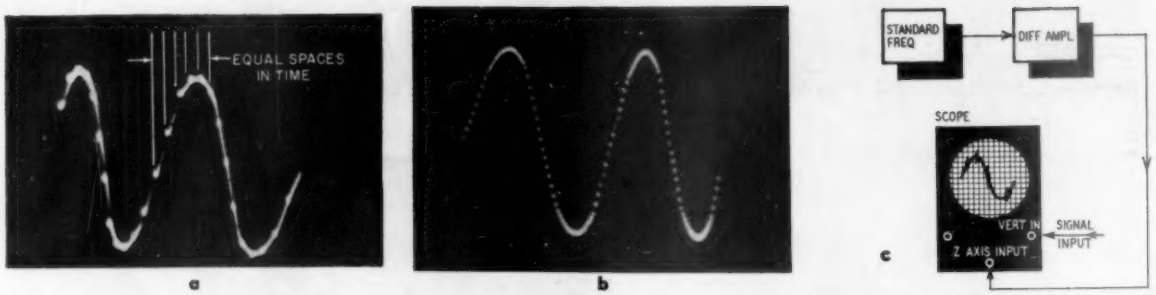


Fig. 3—Marking waveform with dots for frequency measurement, using: a—positive pulses; b—negative pulses; c—test setup.

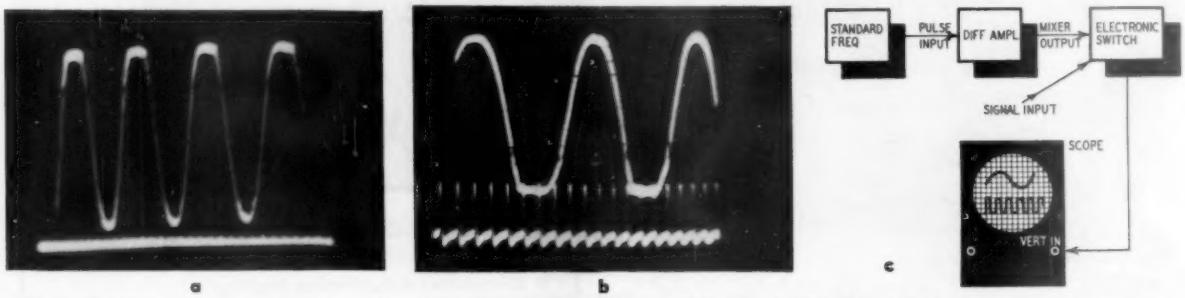


Fig. 4—Timing scales on scope screen for frequency calculations: a—10-kc; b—100-kc; c—block diagram of test setup.

pieces with the amplifier. Using the markings on our bezel to line the ellipse up in the exact center of X and Y axes, we need only count the spaces between dots in one quadrant to find the phase angle in steps of 5°. In Fig. 2 there are 5.8 spaces (the last digit is estimated) between the axes in the fourth quadrant, thus we have $5.8 \times 5 = 29°$ of phase shift. To those familiar with ellipse shapes as various phase angles, it will be obvious that this is an accurate figure.

Besides the phase-measuring aids this little tool can provide, here are some other uses for it:

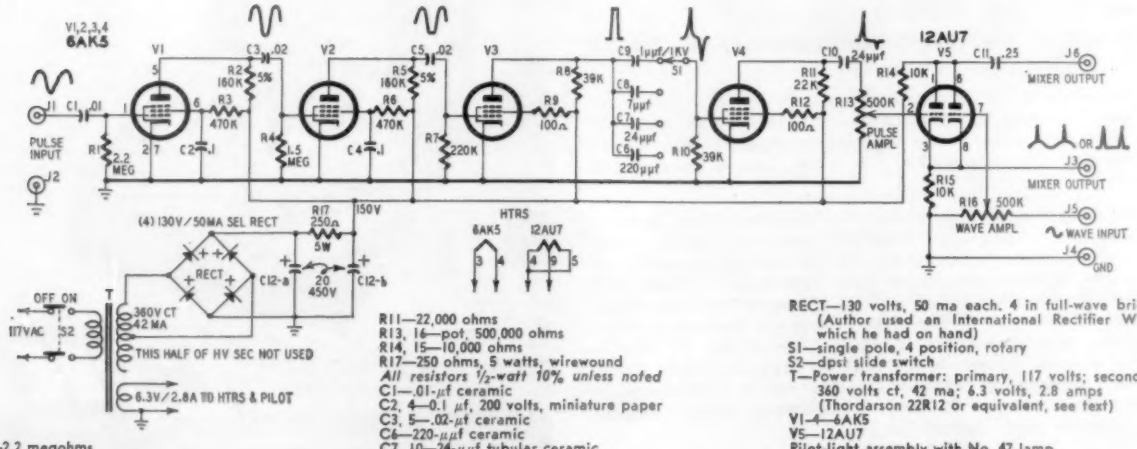
1. Forming trigger pulses for scope sweep or gating.
2. Marking ellipses for frequency measurement.
3. Marking waveforms with dots or holes, as shown in Fig. 3, for frequency measurement or waveform analysis. The pips being exactly spaced in time will divide the wave picture for graphical analysis.
4. Providing timing scales on the oscilloscope face with the use of a frequency standard, as shown in Fig. 4.
5. A general-purpose pulse type amplifier for scope Z-axis modulation.
6. Making fast single-sweep traces on the scope.
7. A simple but, for some purposes, adequate pulse modulator.

The experimenter will be able to think of many other uses for this versatile instrument.

The circuit

Now let's examine the circuit that performs all these tricks. Fig. 5 is the complete diagram. The first three stages are conventional overdriven amplifiers using 6AK5 pentodes, which square almost anything presented at the input. (Note that the time constants of the circuit are gradually diminished as we progress through the stages.)

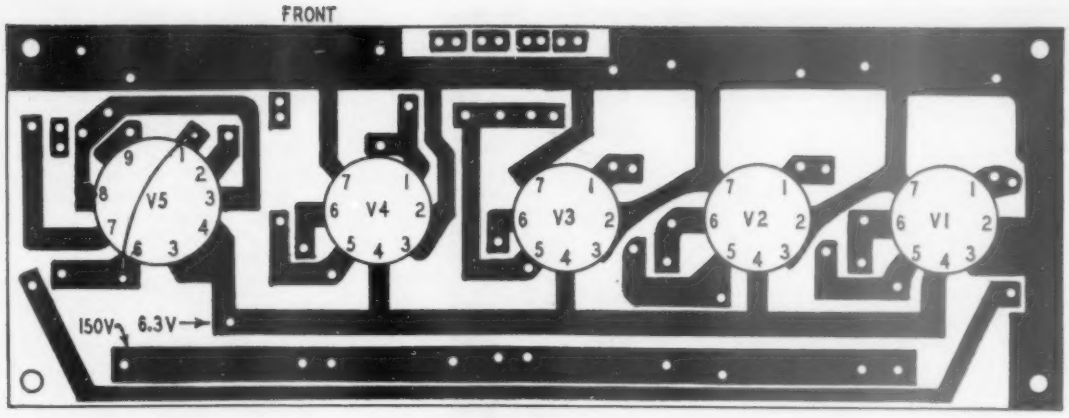
The squared voltage at the plate of the third 6AK5 is fed to the differentiating circuit formed by either capacitor C6, C7, C8 or C9, as selected by



R1—2.2 megohms
R2, 5—160,000 ohms, 5%
R3, 6—470,000 ohms
R4—1.5 megohms
R7—220,000 ohms
R8, 10—39,000 ohms
R9, 12—100 ohms
R11—22,000 ohms
R13, 16—pot, 500,000 ohms
R14, 15—10,000 ohms
R17—250 ohms, 5 watts, wirewound
All resistors ½-watt 10% unless noted
C1—.01-μf ceramic
C2, 4—0.1 μf, 200 volts, miniature paper
C3, 5—.02-μf ceramic
C6—220-μμf ceramic
C7, 10—24-μμf tubular ceramic
C8—7-μμf tubular ceramic
C9—1-μμf disc ceramic, 1,000 volts
C11—0.25 μf, 200 volts, miniature paper
C12—20-20 μf, 450 volts, electrolytic, can type
All capacitors 600 volts unless noted
J1-6—3-way binding posts

Fig. 5—Circuit of the 5-tube instrument.

RECT—130 volts, 50 ma each. 4 in full-wave bridge. (Author used an International Rectifier W15BP which he had on hand)
S1—single pole, 4 position, rotary
S2—dpst slide switch
T—Power transformer: primary, 117 volts; secondary, 360 volts ct, 42 ma; 6.3 volts, 2.8 amps (Thordarson 22R12 or equivalent, see text)
V1-4—6AK5
V5—12AU7
Pilot-light assembly with No. 47 lamp
Sockets, 7-pin miniature (4)
Socket, 9-pin miniature
Cabinet, 6 x 5 x 9 inches
Printed-circuit laminate, 2¼ x 6¼ inches
Knobs
Miscellaneous hardware



BOTTOM VIEW - FULL SIZE

Fig. 6—Wiring side of printed-circuit board.

switch S1 and resistor R10. This differentiating network presents sharp positive and negative spikes to V4's grid. Because of the low plate voltage, the tube has a very low sharp-cutoff point and amplifies only the positive spikes efficiently, losing most of the negative spikes in the cutoff region. Switch S1 lets us select our pulse width. Were we to use the smallest capacitor on low-frequency square waves, we would find that attenuation had swallowed most of our pulse, or the pulse would be such a rapid excursion of the vertical trace that we could hardly detect it. However, for the higher frequencies we must reduce the time constant of the differentiating network. Thus switch S1 controls the pulse width. Since the pulses are essentially triangular, we also have a way to control the pulse slope—useful if we intend using the pulses for fast sweep.

After the differentiated pulse is amplified, it is applied to the attenuator for one half of the 12AU7 cathode follower–mixer. The other half is available for the original wave or any other waveform we wish to mark. The result is that we also have control of the relative size of the spike superimposed on the waveform. In the cathode follower, the voltage swings at the plate and cathode are 180° out of phase or opposed in polarity. Thus we can have positive pulses from the cathode, and negative pulses from the plate if we need them.

The power supply is conventional. It must supply about 20 ma at 150 volts and be well filtered. But neither the voltage nor the regulation is critical. I used the full-wave bridge rectifier because I happened to have it in the junkbox. A simple full-wave or even half-wave power supply will perform adequately as long as approximately 150 volts dc is present.

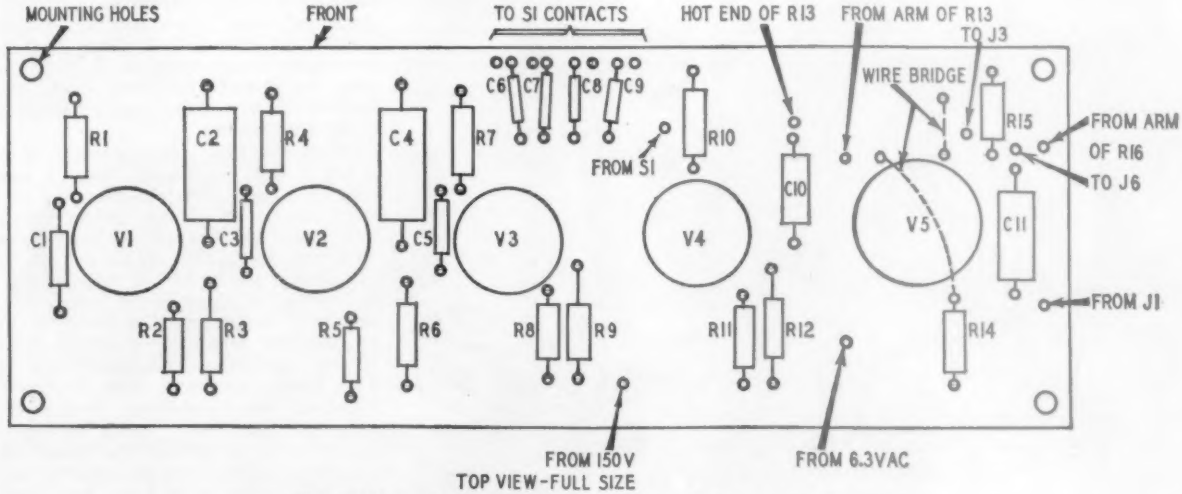
Building the unit

Since the circuit is so well saturated that nothing in it is particularly critical, almost any construction method can be used. However, for the sake of simplicity and neatness, I used an etched-circuit board holding most of the parts. A full-scale reproduction of it is shown in Fig. 6, while the layout of the components is shown in Fig. 7. The holes for the 6AK5 sockets are ⅝ inch in diameter, while the 12AU7 socket requires a ¾-inch hole.

As you can see there is one bridging wire from pin 1 to pin 6 of the 12AU7 socket. This ties the plates together.

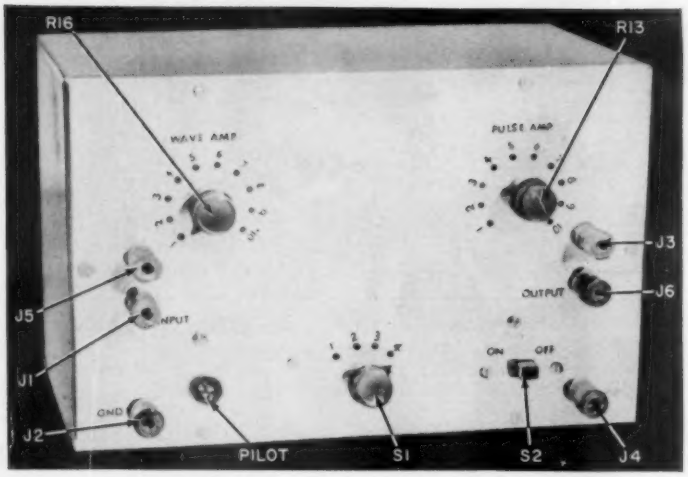
The power supply is entirely separate from the circuit board and is mounted on the rear of the chassis (see photos). If you wish, the power supply need not be built in and some other external supply can be shared by this amplifier.

The tube sockets are inserted into the holes and their lugs bent toward the printed-wiring board and soldered. Be careful in soldering that not too much heat reaches the foil. It might separate. Also use only good-quality rosin-core solder. Any corrosive flux would soon eat through the thin foil of the laminate and cause trouble. There is some advantage in tinning the circuit lines after etching, giving a little more thickness and some chemical protection to the foil. However, this is not strictly necessary.

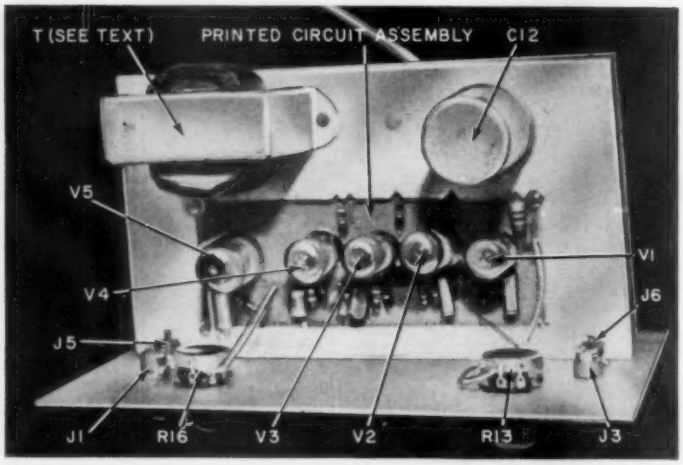


TOP VIEW - FULL SIZE

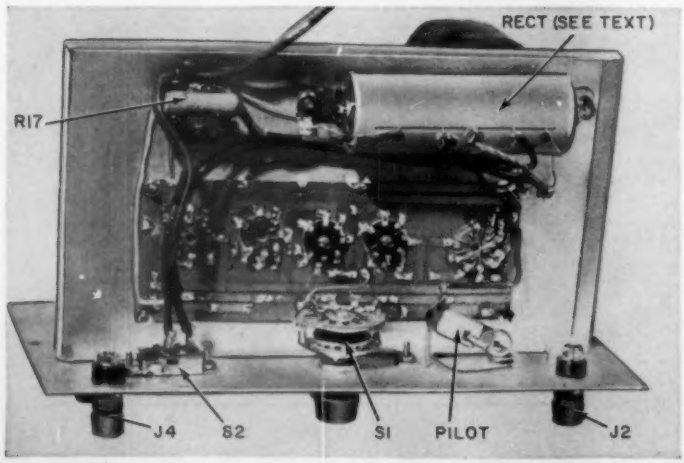
Fig. 7—Top view of printed-circuit board shows parts layout.



Front-panel layout of differentiating amplifier.



Top-chassis view of the completed unit.



A look under the chassis shows power supply wiring.

Sharp-eyed readers will notice a slight difference in the circuit board in the photos and the template. The template is a slightly improved version, doing away with one additional crossover and one long wire to a potentiometer. The template has been carefully tested and is accurate.

The cabinet is an aluminum utility box 6 x 5 x 9 inches, and the chassis is bent from a piece of aluminum and attached to the front panel with two screws. There is not enough weight on the chassis to require extra bracing, if the screws are pulled up tightly.

Wire is used to connect the binding posts, the potentiometer and the pilot-light and power supply to the printed-circuit board. Short pieces of bare wire connect switch S1 to the circuit board. The circuit-board ends of these connections are clearly marked on the top-view diagram of the circuit board.

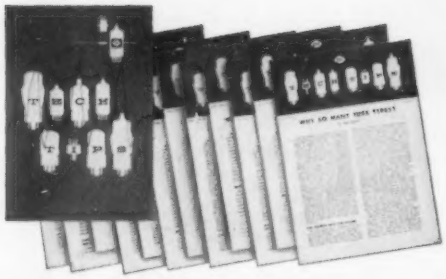
Metal rims on the tube sockets will not be needed and, if present, should be removed. The bent and soldered lugs will hold the sockets firmly in place. The circuit board has been designed to fit behind a rectangular hole, 2⅛ x 6⅛ inches, but with corners saved for mounting screws. Do not depend on the mounting screws to provide a solid ground connection. Several amps of heater current must be returned to ground. The best method is to connect all points to be grounded at a common location, such as the lugs on the filter capacitor can, for example.

The amplifier in use

You can use two of these amplifiers for accurate phase measurement, doing away with the electronic switch and connecting the pulse output of one amplifier to the wave input of the other to produce two sets of spikes. We must remember several points in this respect, however.

Phase difference is in essence a displacement in time. When we measure phase in a network or an amplifier, we measure how much one leads or lags the other. Any capacitance or inductance will introduce a certain amount of phase shift, depending on the relative time constants of the wave and the circuit. For very high frequencies, even a small capacitance will make a difference.

What we must then consider *with great care* in measuring phase is any possible phase shift introduced by our instruments. If we use an electronic switch with attenuators, we must make sure that no significant phase shift is introduced there. If we can set our attenuators at exactly the same point, and their construction is identical in all respects, we are reasonably safe. If any parallel stray capacitance is very small, we have little to worry about at low frequencies. Remember, however, that each input capacitor followed by a variable resistance of some sort makes a sort of phase shifter. The best policy is to make sure that the circuits we use to measure phase



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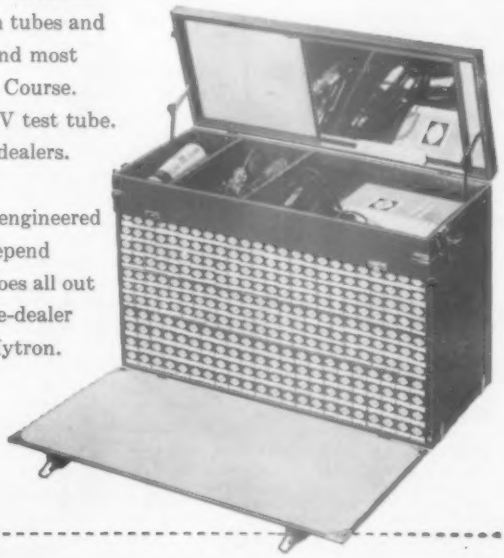

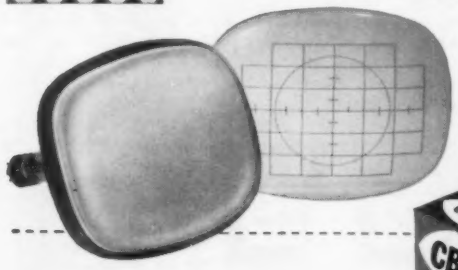

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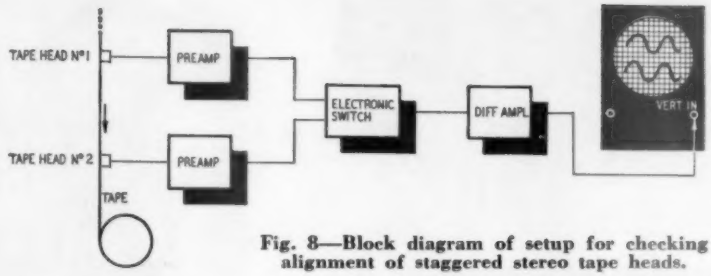

Fig. 8—Block diagram of setup for checking alignment of staggered stereo tape heads.

in two voltages are identical and do not introduce a phase difference of their own. We can quickly check this by applying the same voltage to both inputs of the electronic switch and noting the distance between pips, if any, at the desired attenuator settings. We must then, if there is a space, substract this length from the measured phase shift. *This is a very important point and must not be overlooked if accurate measurements are to be made.*

Another important item is that the location of the pips can be affected by waveform. If we try to determine phase between a sine wave and a square wave, the phase difference appears a little greater if the square wave is leading and a little smaller if the sine wave leads. This occurs because the square wave saturates the amplifier just a little faster than the sine wave. If we have sufficient amplitude, say 1 volt or more, we have little to worry about, since the brute force of such a sine wave will saturate the amplifier so very nearly in the same time interval that not much difference can be seen. However, if the voltage is fairly low and the difference in waveform extreme, we would be better off using the ellipse method with 72 times the original frequency. Our ellipse will be very distorted, and the spaces between pips may appear unequal. But there we depend only on a counting process basically. However, a phase measurement between radically different waveforms is rare.

If you plan to use a chopper type electronic switch, rather than a synchronized type showing alternate traces, make very sure that the chopping frequency does not synchronize with the waveform to be measured or you may see a whole mess of pips at the chopper frequency. I have found that a chopper type switch is much harder to use for this type of work as only one with adequate blanking will give the nice clean traces which are most useful. The synchronized type of course has no such problems.

To extend the frequency range of the instrument beyond 100 kc, reduce the time constants of the circuits. There will be some loss in gain, of course. Thus, if differentiating resistor R10 is made only 10,000 ohms and capacitors C6, C7, C8 and C9 even smaller, the upper frequency for sharp spikes will go up to at least 500 kc. But remember to increase the input voltage to make up for the decreased saturation of the circuits.

Where to use it?

I have found this amplifier to be a useful and inexpensive addition to my instrument collection, indispensable for designing phase-shift networks in the audio-frequency spectrum. But there are many other uses for it. Here are some of them:

In the audio field, phase measurement is important in the performance evaluation of audio amplifiers. These can be measured stage by stage or overall. The method is the same as indicated in Fig. 1, except that what is indicated as "phase-shift device" now becomes a stage of an amplifier or the whole amplifier.

Similarly we can check the phase shift in amplifiers and preamplifiers of a stereophonic sound system. Here phase shift is extremely important, since the stereo effect is partially a result of the phase difference of the sound at both ears. A significant phase difference in the amplifiers can cause a loss or an exaggeration of the stereo effect. In stereo we sometimes use staggered heads, particularly when the heads have been added to an existing recorder. The precise location of the head is vital. With the head displaced any significant amount more or less than the displacement of the tracks on the tape, some of the musicians would seem not to be keeping time. To use the amplifier for this work you first measure the phase shift of the

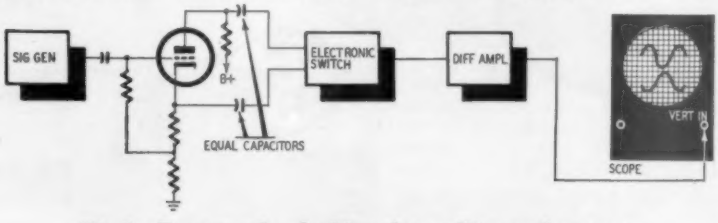

Fig. 9—Test setup for checking phase-splitter performance.

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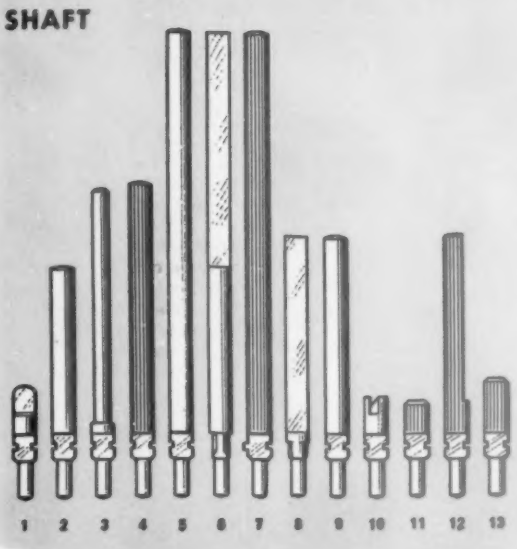
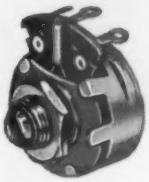


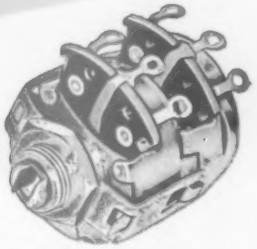
1 ⅜" long male for female fitting.
2 2" round shaft.
3 3" round shaft, ¾" dia.
4 3" knurled split shaft.
5 5" round shaft.
6 5" flatted shaft.
7 5" knurled split shaft.
8 3" flatted shaft.
9 3" round shaft.
10 ½" double-flatted Philco-type shaft.
11 ¼" fine knurled shaft.
12 3" knurled flatted shaft.
13 ½" fine knurled flatted shaft.

CONTROLS



Series A 47: ½-watt, 13/16" diameter controls. 500 ohms to 10 megohms.

Series A 47F: ½-watt, 13/16" diameter controls, with taps located at 30%, 50% or 70% of rotation, depending upon resistance value. 50K to 3 megohms.



Series AD 47: ½-watt, 13/16" diameter dual controls for audio, radio, TV and industrial uses. Various taps available. 50K to 5 megohms.

SWITCH

Choice of five switch types including SPST and DPST, for various power ratings. UL approved

CLAROSTAT MFG. CO., INC.

Headquarters for **RESISTORS, CONTROLS,** and **RESISTANCE DEVICES**

DOVER, NEW HAMPSHIRE, U.S.A

In Canada: CANADIAN MARCONI CO., LTD., Toronto 17, Ont.

CDR ROTORS

CUTAWAY VIEW

All new features

Completely designed from the ground up, CDR Model TR-15 and TR-16 Rotors have features never before available in the popular price range. Check these refinements and you'll see why: Quick mounting mast collet . . . speedy installation (no loose parts to assemble) . . . self-centering sawtooth clamps take masts up to 1½" O.D. . . . instant locking prevents drift . . . mechanical brake releases magnetically . . . instantly reversible . . . makes complete revolution in 45 seconds . . . meets JAN salt water test . . . great strength thrust bearing support . . . low weight . . . completely weather-sealed . . . fits standard towers . . . streamlined to reduce wind resistance . . . mahogany or blonde finish control box. Get full details today from your local CDR distributor.

CORNELL-DUBILIER ELECTRIC CORP.
South Plainfield, New Jersey

THE RADIART CORPORATION
Indianapolis, Indiana

CDR
Antenna Rotors

Old Hands at Dependability

two preamps and then the total phase shift of heads and preamps together, using a test tape with a single sustained note. Such a test tape could be made on a recorder which is working satisfactorily. The lower the frequency of the test signal, the more accurate the measurement, since with high frequency you might be several integral cycles off. The setup for measuring tape-head displacement is illustrated in Fig. 8.

Another audio application would be checking the performance of phase splitters at various frequencies. Fig. 9 shows how.

In the radio and TV field there are a number of applications. One would be to check the phase shift of the networks used in single sideband. These must shift phase quite accurately to 90°. Video detectors are sometimes subject to phase distortion with frequency, and this of course would introduce picture distortion.

Industrial uses for phase measurements are many. Much industrial control is accomplished with thyratrons, and control of the firing period of thyratrons is almost universally accomplished with phase-shift networks. With the grid control voltage in phase with the plate voltage the tube will produce maximum average current and by shifting the phase this can be controlled. Accurate setting of the phase shift network could be very important.

Other industrial applications are the checking of phase of generators in parallel. Obviously paralleled generators which are not in phase will produce harmonics and lose efficiency. Phase detectors are used in many industrial equipments. Power-line electronic carrier relays use a phase-shift principle, and their setting is critical. Hundreds of miles of high-voltage lines may depend for protection on one such relay. Similarly in modern power plants the generators are now often paralleled automatically by electronic synchronizers. These instruments measure the phase shift of the generator voltages and, when at any point the shift becomes a certain preset minimum, closes the circuit breakers which put the generators on the line. Automatic synchronizers depend on phase detectors, which must be accurately adjusted.

Phase shift, where needed, can be produced by synchros or selsyns, and to calibrate these the phase measuring instrumentation can also be very useful. There are a multitude of other devices depending on accuracy of phase shift —echo sounders, for example. A time measurement of importance is the reverberation time of large halls or churches at various frequencies. This too can be measured as a phase shift.

Anyone having in his work or hobby a problem of phase or time measurement will find it much simpler if he uses the differentiating amplifier in combination with an oscilloscope and electronic switch. END

TEST INSTRUMENTS

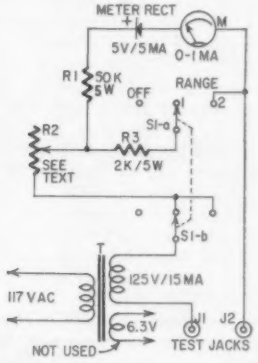
CAP-OHM-METER

Direct-reading unit for in-circuit testing of cathode bypass capacitors

By R. C. SANDISON

THE diagram shows the circuit of a capacitance meter which is accurate enough for all but the most exacting measurements. It can be readily assembled from junkbox parts and even if you do go out and buy the few necessary components, its cost is low. The only thing to make sure of is that the rheostat (R2) is a wirewound unit that covers a wide resistance range. I used an ancient one variable from about 2,000 to 100,000 ohms.

What the meter actually does is measure the capacitive reactance of the capacitor under test. The 117-volt ac



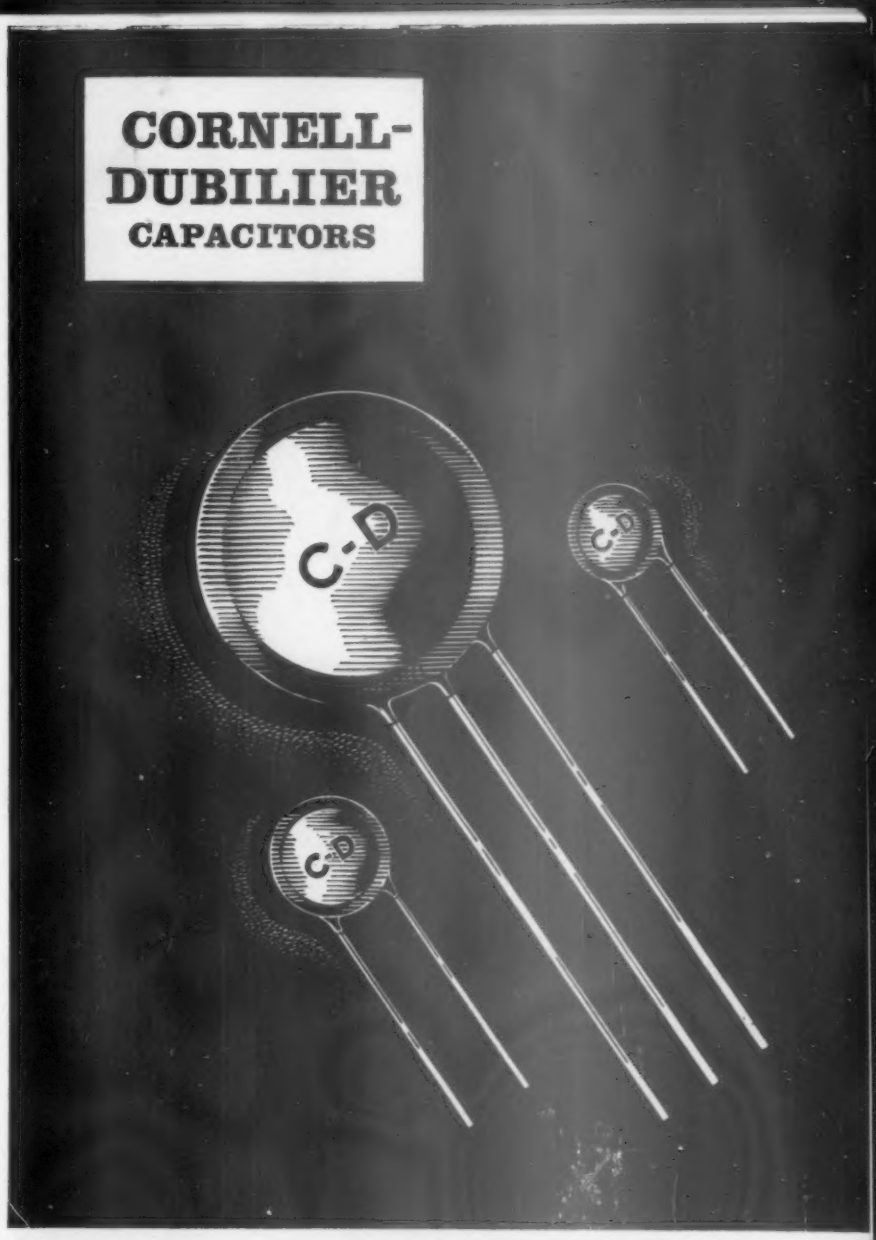
R1—50,000 ohms, 5 watts
R2—see text
R3—2,000 ohms, 5 watts
J1, 2—tip jacks
M—0-1-ma meter
RECT—meter type, 5 ma, 5 volts
S1—single-pole 3-position rotary
T—power transformer: primary, 117 volts; secondary, 125 volts, 15 ma; 6.3 volts, 600 ma
Case to suit
Miscellaneous hardware

Circuit of the useful instrument.

line provides a convenient 60-cycle frequency standard. The meter has two ranges: RANGE 1 covers .001 to 0.1 μf and RANGE 2, .05 to 10 μf, thereby including the more common sizes of capacitors for a quick check. Calibrate your scale by using good, high-tolerance capacitors for test measurements.

As the meter reads the capacitive reactance or effective resistance of the capacitor under test at 60 cycles, it can also be used as an ac ohmmeter. In this service only RANGE 1 is used. The resistance range may be calibrated with known resistors.

To make a quick check for shorts or opens in a cathode bypass capacitor without unsoldering, measure the resistance of the R-C combination first with this circuit and then with a dc ohmmeter. If both readings are exactly the same, the capacitor is obviously open or shorted. To make this a speedier test you can arrange your test leads so that they can be switched from one meter to the other. END



The Ceramics with the "worries" removed

If you want ease of mind, take a second look at C-D Ceramics . . . the Ceramics with the "MILLION DOLLAR BODY." Even if they were costly—which they're not—they would be the most economical replacements you could use. Because C-D Ceramics remain stable, won't melt, and are virtually immune to shorts and opens.

Besides, C-D Ceramics have a quality that can't be matched—because their manufacture, all under one roof, is rigidly supervised from raw materials to finished product.

Next time you need to replace a bypass or blocking capacitor, use a C-D Ceramic. They're available from your local C-D distributor in all the popular values and voltage ratings. Catalog 200D-3 is yours for the asking. Just write Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey, Dept. REC-9.

CORNELL-DUBILIER CAPACITORS

Old Hands at Dependability

RADIART VIBRATORS

Consistently dependable power

Next time an auto-radio vibrator replacement is called for, try Radiart. There's a complete line for all 6-volt and 12-volt applications. And no waiting for the type you want, because your local Radiart Distributor maintains a full stock for your convenience. Ask him for your free copy of the Radiart Vibrator Replacement Guide, or write toDpt.REV-9,The Radiart Corporation, Indianapolis 5, Indiana.

RADIART TOBE Vibrators

Old Hands at Dependability

Technicians' News

"FREE" LABOR WARRANTIES

The biggest change in the 1959 TV lines is the "free" 90-day parts *and labor* warranty which some of the biggest television set manufacturers are urging on their distributors. Some independent technicians have attacked this as an extension of captive service.

RCA was first to recommend such a policy for 1959 TV sets, and several manufacturers immediately followed suit while others have said they are considering the idea. Here's how it works: At the option of the distributor, an extra charge (usually about $4) is tacked onto the list price of the set. This covers a 90-day service policy which covers all parts and labor—in the home or in the shop, the repairs being handled by the distributor's service department (or in the case of RCA, by the RCA Service Co.). Similar policies have been adopted for some hi-fi and radio lines. At least one manufacturer has been offering parts and service for 1 year for portable TV's.

The television retailer is free to join the program offered by the distributor or to stay away from it. Where such a deal is offered, it's generally expected that most retailers will go along because of the low price of the warranties. While some distributors have previously offered such warranty policies on their own, it now appears that most leading manufacturers are seriously considering adopting parts-and-labor warranty plans.

SERVICE COSTS COMPARED

The average TV owner spends less for repairs through his local independent technician than he would through many of the contract services. This conclusion was reached by C. A. Stevens, board chairman of the Electronic Technicians Association of Toledo, Ohio (ETAT), writing in *ETAT News*, on the basis of a survey of his own customers.

Selecting a random sample of 85 steady customers from his files, he found that 10 of them averaged 3 service calls a year, 20 averaged 2 and 55 averaged 1. These 85 case histories involved 125 home service calls in a typical year, with 22 sets brought into the shop for repairs.

Analyzing the jobs done for these customers, he compared them with a popular contract service in the Toledo area, which charges $12 a year, plus $1.95 for each home call, $4.85 for shop repairs, with 20% off list for parts.

The total charges for the 125 repair

jobs done under Stevens' flat-rate schedule amounted to $1,797.54. The same repairs, on the contract basis, would have cost the set owners $2,221.63.

ARTSNY COLOR COURSE

A 10-week course in color TV repair, conducted by Paul Goldberg, is being repeated by demand of the members of Associated Radio–Television Servicemen of New York (ARTSNY).

Held at ARTSNY's Ridgewood TV Clinic, it is one of a series of technical courses and lectures sponsored by the group for its members.

The association has a policy of providing courses on any electronic subject requested by a minimum of 30 members. An innovation is a course in air conditioning being presented for the first time. In another phase of ARTSNY's technical program, manufacturers are being invited to send representatives to talk on the proper servicing of their products.

AD CAMPAIGN SUCCEEDS

The power of organized technicians in policing set manufacturers' advertising claims was demonstrated when Westinghouse Electric Corp. advised the Federation of Radio–Television Service Associations of Pennsylvania (FRTSAP) that it was discontinuing advertising statements to which the federation had objected (RADIO-ELECTRONICS, August, 1958, page 95).

After a thorough testing program, FRTSAP had filed a formal objection to the manufacturer's claims of elimination of fading in three-way portable radios. FRTSAP's 15 chapters throughout Pennsylvania are continuing tests of television and radio receivers and have protested other performance claims which have "caused the service industry many unnecessary problems and hardships." A spokesman said results of the tests will be submitted to the Federal Trade Commission. Exaggerated performance claims, a FRTSAP statement said, "are being made at the expense of the independent technician."

ARTSD SUGGESTS COLOR RATES

These suggested fair charges for color TV servicing were adopted by the consumer guide of the Associated Radio-Television Service Dealers (ARTSD) of Columbus, Ohio: Half-hour service call, $6.95; $2 per quarter-hour thereafter; bench work, $7 per hour.

TOBE

America's Fastest-Growing Service Capacitor Line...

NEW!

TOBE MYLAR* MOLDED TUBULAR CAPACITORS

- *Molded of DuPont Mylar*, one of the finest insulation materials ever developed.
- *Thermoset Case Construction* secures leads and sections firmly to withstand extremes of handling, vibration, shock and soldering temperatures.
- *High Insulation Resistance:* Average megohm values per unit 10,000 at 25°C. Small capacitance variation with thermal change.
- *Temperature Operating Range:* –55° to +130°C.
- *Moisture Resistant:* Exceeds JAN-C-91 requirements.
- *Non-Inductive:* Extended foil construction insures low resistance connections and low RF impedance.

DESIGNED FOR SERVICE DEALERS

NEW TOBE MYLAR* CAPACITOR KIT

FREE KIT CONTAINS 80 CAPACITORS

ONLY $15.84

Today, order your Tobe Mylar Kit from your Tobe Distributor

Compact, clear-plastic dispenser contains an assortment of 80 Tobe Mylar capacitors in the most popular sizes, ratings and quantities for quick, efficient servicing. Covers over 60 different ratings at 200, 400 and 600 working volts and from .0001 to 1.00 mfd. Dealer pays only for the Tobe Mylar capacitors, kit is free.

TOBE RADIART CAPACITORS

*DuPont trademark

TOBE DEUTSCHMANN CORPORATION, NORWOOD, MASSACHUSETTS

get ready for tomorrow... today

with **RCA COLOR TEST EQUIPMENT**

The alert service technician knows that his big future is not just around the corner—it's here today—in color-TV servicing! To get your share of this fast-growing market, you need the right kind of equipment. Get the right start! Make the right kind of investment with

RCA PROFESSIONAL COLOR TEST EQUIPMENT

WR-46A VIDEO/DOT CROSSHATCH GENERATOR for making static and dynamic convergence adjustments in color-TV sets.

- **Video output adjustable in amplitude on all patterns from 0 to 45 peak v across 4000-ohm load**
- **Vertical bars continuously adjustable from 10 to 25 (approx.) bars**
- **Cable connections on back of cabinet**
- **Reversible video output polarity**
- **Simple connections to TV receivers**

WR-61B COLOR-BAR GENERATOR—essential for checking overall operation of color-TV receivers and for adjusting and trouble-shooting color phasing and matrixing circuits.

- **Amplitude of color subcarrier and color-burst signal adjustable from front-panel for checking color synclock action of set**
- **Both rf and video output available—video output has both "+" and "—" polarity**
- **RF output voltage, at least 0.01 volt peak to peak; video output voltage—at "Lo" connector, at least 0.25 volt peak to peak across 75 ohms; 8 volts peak to peak across 4700 ohms at "High" video output terminal**

Write for technical literature describing these RCA Test Instruments and for the line flyer describing RCA's complete line of both color and black-and-white test instruments.

RADIO CORPORATION OF AMERICA

Electron Tube Division — **Harrison, N. J.**

RCA Commercial Engineering, Section 1-39-W
Harrison, New Jersey

Rush me the following literature on RCA professional Test Equipment!

☐ CD-57-6 (RCA WR-61B Color Bar Generator) ☐ 3F764 (RCA Test Equipment Line Flyer)
☐ CD-57-7 (RCA WR-46A Video/Dot Crosshatch Generator)

Name.....

Company.....

Address.....

City.....Zone.....State.....

Among other recent ARTSD activities: By unanimous vote, the association requested its licensing committee to draft a technician licensing bill, which will be proposed to city authorities. Also unanimously, the members who service auto radios agreed to a cooperative arrangement whereby they will set up pushbuttons for customers on the frequency of local radio station WMNI in exchange for spot announcements boosting the association.

LOW-PRESSURE SELL URGED

Next to the family doctor, the TV technician has the best "in" with the customer in his own own home—and he should take advantage of this position to do some selling. So said Lee Naylor, Western district sales manager of Channel Master Corp. in an address to the California State Electronics Association (CESA) convention in Fresno.

"Bring a portable radio along on the job," he suggested, "and let it play in the customer's home as the technician works." Charging that the service industry is not sufficiently sales-minded, he cited a survey by his own firm which indicated that 75% of service dealers never ran an antenna promotion; 90% did not follow up his company's national magazine advertising campaign—but those who did succeeded in making sales on 50% of their calls.

James Wakefield, Cardinal Electronics Service, Fresno, was elected CSEA 1958–59 president, succeeding H. Lawrence Schmitt of Burlingame, Calif.

Other new officers: Ray Warthen, Electronics Service Co., Vallejo, vice president, and Art Blumenthal, Art Blumenthal Co., Redwood City, secretary-treasurer.

NATESA ADDS 100TH

The National Alliance of Television & Electronics Service Associations (NATESA) recently added its 100th affiliate association—the Tri-State TV Association, with headquarters in Texarkana, Tex.—and kept right on growing, to a total of 104 local member groups. Nine local and regional groups were accepted as NATESA affiliates in a 30-day period.

GROUP EXPELS 7 FIRMS

Seven Kansas City TV service firms were expelled from Television Service Engineers (TSE) of Kansas City on the grounds of "breach of ethics" and violation of "the spirit of the association and its bylaws." The expulsion, voted by a majority of the TSE membership, was followed by suspension of the same firms from Television & Electronic Service Association of Missouri.

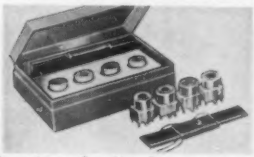
The seven companies reportedly were associated with a parts distributor in a venture called "Courtesy TV" which advertised free tube testing in the home. END

new Devices

COMMUNITY TV AMPLIFIER, *model SPA.* Rated at 20 volts output into 75-ohm lead, equaling more than 5 watts at bandwidth of over 6 mc. For any

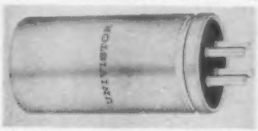
vhf channel. Designed for continuous commercial service. Input of 1 volt required.—**Seg Electronics Co. Inc.,** 1778 Flatbush Ave., Brooklyn 10, N. Y.

RECEIVER COIL KIT, *MS-450.* For subminiature transistor broadcast receiver circuits. 3 455-kc shielded if coils and oscillator coil, each only 19/32 inch above chassis and ⅝ inch in



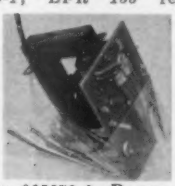
diameter, ferrite loop antenna plus miniature 2-gang *Poly-Vari-Con* tuning capacitor. *MS-440* has same coils less capacitor. —**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

TRANSISTOR VIBRATOR REPLACEMENT, *Univistor* line. Direct replacements for mechanical vibrators. 2 germanium power transistors make up



switching element, in conjunction with existing vibrator transformer, to convert dc to ac. Operating life more than 10,000 hours, compared with 400–500-hour vibrator average. —**Universal Transistor Products Corp.,** 17 Brooklyn Ave., Westbury, N. Y.

FLYBACK TRANSFORMERS. *Model EFR 134* replaces *Bendix 265075-1; EFR 135* replaces



Bendix 265078-3—**Rogers Electronic Corp.,** 49 Bleecker St., New York 12, N. Y.

TUNABLE MOBILE RADIOS. *Model M-40* (shown) operates

in 30–50-mc band, *model M-160* in 152–174-mc band. Both have double - conversion tuned rf stages, 2-mv sensitivity, built-in adjustable squelch, 4 - inch speaker, sliderule dial.—**Monitoradio Div.,** I.D.E.A. Inc., 7900 Pendleton Pike. Indianapolis.

VHF CONVERTER, *model VHF-126.* Extends range of any com-

munications receiver through 6-, 2- and 1¼-meter amateur bands. Built-in power supply. Utilizes low-frequency if stage of ham receiver. Fast and micrometer tuning. Direct reading in megacycles. — **Radio Manufacturing Engineers Inc.,** Div. of Electro-Voice Inc., Buchanan, Mich.

FM–AM TUNER, *models FA-11 and FA-12.* FM multiplex jack.

Sensitivity 5 μv for 30-db quieting on FM, 200 μv/m for 20-db signal-to-noise ratio on AM. FM maximum deviation sensitivity 5 μv. Afc. Tuning meter for AM and FM. Folded-dipole FM antenna, ferrite-rod AM antenna. Cathode-follower audio outputs. Maximum 1½% harmonic distortion, less than 2% IM.—**General Electric Co.,** Specialty Electronic Components Dept., W. Genesee St., Auburn, N. Y.

CABINETS AND ENCLOSURES. New line includes

equipment cabinets and speaker enclosures in variety of finishes. Leatherette-covered console *CBC-8-12* has swivel base (shown).—**Wellcor, Inc.,** 1214 N. Wells St., Chicago, Ill.

SPEAKER SYSTEMS, *Wharfedale.* Small-sized units adaptable to stereo room arrangements. *W/AF/2* (shown) *contains Super 12/FS/AL* 12-inch speak-

The specs are the proof...now your best buy in ham equipment is EICO

New 90-WATT CW TRANSMITTER #720
KIT $79.95 WIRED $119.95

Conservative, highly efficient design plus stability, safety, and excellent parts quality. Covers 80 thru 40, 20, 15, 11, 10 meters (popular operating bands) with one knob band-switching. 6146 final amplifier for full "clean" 90W input, protected by clamper tube circuit. 6CL6 Colpitts oscillator, 6AQ5 clamper, 6AQ5 buffer-multiplier, GZ34 rectifier. "Novice limit" calibration on meter keeps novice inside the FCC-required 75W limit. No shock hazard at key. Wide range, hi-efficiency pi-network matches antennas 50 to 1000 ohms, minimizes harmonics. EXT plate modulation terminals for AM phone modulation with 65W input. Excellent as basic exciter to drive a power amplifier stage to maximum allowable input of 1KW. Very effective TVI suppression. Ingenious new "low silhouette" design for complete shielding and "living room" attractiveness. Finest quality, conservatively rated parts, copper-plated chassis, ceramic switch insulation. 5" H, 15" W, 9½" D.

NEW UNIVERSAL MODULATOR-DRIVER . . . . #730
KIT $49.95 WIRED $79.95 Cover E-5 $4.50

Superb, truly versatile modulator at low cost. Can deliver 50 watts of undistorted audio signal for phone operation, more than sufficient to modulate 100% the EICO #720 CW Transmitter or any xmitter whose RF amplifier has a plate input power of up to 100W. Multi-match output xfmr matches most loads between 500-10,000 ohms. Unique over-modulation indicator permits easy monitoring, precludes need for plate meter. Low level speech clipping and filtering with peak speech frequency range circuitry. Low distortion feedback circuit, premium quality audio power pentodes, indirectly heated rectifier filament. Balance & bias adjust controls. Inputs for crystal or dynamic mikes, phone patch, etc. Excellent deluxe driver for high-power class B modulation. ECC83/12AX7 speech amplifier, 6AL5 speech clipper, 6AN8 amplifier driver, 2-EL34/6CA7 power output, EM84 over-modulation indicator, GZ34 rectifier. Finest quality, conservatively rated parts, copper-plated chassis. 6" H, 14" W, 8" D.

NEW GRID DIP METER . . . . . #710
KIT $29.95 WIRED $49.95 including complete set of coils for full band coverage.

Exceptionally versatile. Basically a VFO with micro-ammeter in grid; determines freq. of other osc. or tuned circuits; sens. control & phone jack facilitate "zero beat" listening. Excellent absorption wave meter. Ham uses: pre-tuning & neutralizing xmitters, power indication, locating parasitic osc., antenna adj., correcting TVI, de-bugging with xmitter power off, determining C,L,Q. Servicing uses: alignment of filters, IF's; as sig. or marker gen. Easy to hold & thumb-tune with 1 hand. Continuous 400 kc – 250 mc coverage in 7 ranges, pre-wound 0.5% accurate coils. 500 ua meter movement. 6AF4(A) or 6T4 Colpitts osc. Xmfr-operated sel. rect. 2¼" H, 2¾" W, 6¾" L. Satin deep-etched aluminum panel; grey wrinkle steel case.

IN STOCK! Compare & take them home — right "off the shelf"—from 1900 neighborhood EICO dealers — no mail delays, no high penalty freight costs. For free catalog mail coupon. Over 1 MILLION EICO instruments in use throughout the world. Add 5% in the West

Send for FREE CATALOG now C-9
EICO, 33-00 Northern Blvd., L.I.C. 1, N.Y.
Show me HOW TO SAVE 50% on 60 models of top-quality equipment (in box I have checked here: ☐ HAM GEAR ☐ HI-FI ☐ TEST INSTRUMENTS. Send FREE literature and name of EICO dealer.
NAME.....
ADDRESS.....
CITY..... STATE.....

See EICO's Hi-Fi and Test Equipment ads on Pages 29 and 30.

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er, *Super 3* tweeter with balancing control; 36⅜ x 23 x 15⅝ inches. Enclosure *AF/12/Cab* available separately. *W/AF/1* is 30 x 17 x 12 inches, with *W10/FSB* 10-inch speaker, tweeter, balancing control. Enclosure is *AF/10/Cab*.—**British Industries Corp.**, 80 Shore Rd., Pt. Washington, N. Y.

WOOFERS, *Tempo. Model W12K508* is 12-inch speaker with 10-ounce Alnico V magnet, 1¼-inch voice coil, 15-watt power-handling capacity; 4,000-cycle rolloff, 50-cycle resonance. *Model W12M608:* 12-inch, 20-

ounce magnet, 1½-inch voice coil, 25-watt capacity, rolloff at 3,000 cycles, 45-cycle resonance. *Model W15M608;* 15-inch, with 20-ounce magnet, 1½-inch voice coil, 25-watt power capacity, 2,000 cycle rolloff, 40-cycle resonance.—**Oxford Components Inc.**, 556 W. Monroe, Chicago.

LOUDSPEAKER SYSTEM, *model Six.* Requires slightly more than 1 foot floor space; 23½ inches high. 12-inch acoustic suspension woofer, cone type direct-radiator tweeter.—

KLH Research & Development Corp., 30 Cross St., Cambridge 39, Mass.

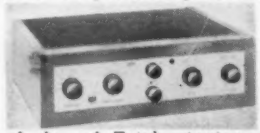
AMPLIFIER–SPEAKER, *Stereo Companion model 560.* Designed for conversion of existing Fisher phono and radio–phono units.

Volume, bass and treble adjustments controlled from panel on main unit. Peak power 32 watts. 3-speaker system.—**Fisher Radio Corp.**, 21-21 44 Dr., Long Island City 1, N. Y.

PACKAGED HI FI, *model AUV-36.* One of a line of hi-fi packages. For use as basic system or stereo conversion. Fiberglass-loaded cabinet, Jensen speaker

system, 10-watt Bell amplifier.—**Universal Woodcrafters Inc.**, La Porte, Ind.

STEREO AMPLIFIER–PREAMP, *Eico model HF81,* kit or wired form. Separate low- and high-level inputs in each channel, including FM multiplex and auxiliary inputs. Ganged level controls and separate balance control. Williamson type push-pull EL84 power amplifiers in



each channel. Total output power 28 watts continuous (14 watts each channel), 56 watts peak. Response ±0.5 db, 10–100,000 cycles at 2 watts. 10 tubes.—**Electronic Instrument Co. Inc.**, 33-00 Northern Blvd., Long Island City 1, N. Y.

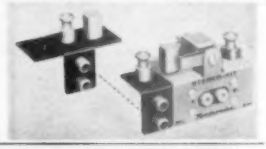
MONAURAL–STEREO PREAMP kit. Monaural *model SP-1* is basic preamplifier, which may be converted to stereo without

rewiring by using *model C-SP-1* conversion kit. Complete model *SP-2* (stereo) has 12 inputs, 6 on each channel, with input level controls. 6 dual-concentric controls include 2 bass, 2 treble, 2 volume level, 2 loudness controls, scratch filter, 4-position function switch. EF86 tubes used in input. Two cathode-follower outputs. Remote balance control with 20 feet of cable. 2 printed-circuit boards and encapsulated circuits.—**Heath Co.**, Benton Harbor, Mich.

STEREO CONTROL KIT, *Dynakit DSC1.* May be added to pair of preamps or amplifiers. Dual volume control, balance control, loudness compensation with disabling switch, channel-reversing switch, dual tape-monitor switch.

Auxiliary "blend" control permits mixing stereo channels in controllable proportion.—**Dynaco Inc.**, 617 N. 41 St., Philadelphia 4, Pa.

STEREO CONVERSION for tape recorders. *Stereo-Kit SK-100* converts monaural recorders for reproduction of standard 2-channel stereo tapes; *SK-50*



New Autospeed Changer

ASR-433 Stereo Amplifier—Selected for display at the Vienna International Fall Fair.

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In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive all parts, tools, instructions, etc. There is nothing else to buy. Everything is yours to keep.

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J. Stataitis, of 23 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

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for 4-channel tapes. Also available *PL-100* playback amplifier for second sound channel, *RA-100* recording amplifier for stereo recording using *Stereo-Kit* conversion, *EK-100 Erase-Kit* for 2-channel *Stereo-Kit*, *EK-50* for 4-channel.—**Nortronics Co. Inc.**, 1011 S. 6 St., Minneapolis 4, Minn.

BASIC AMPLIFIER, *Knight model KN-632.* For use with any tuner or preamp having volume and tone controls. 32 watts. Variable damping adjust-

ment for optimum performance with any speaker system. Output taps of 4, 8 and 16 ohms. Input level control. Maximum output delivered from 0.7-volt input. Response ±0.5 db from 20 to 40,000 cycles at full output. Harmonic distortion less than 0.5% at mid-frequencies, maximum 1.5% at full output.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

STEREO PREAMPLIFIER, *model 130.* Front panel controls: selector switch, stereo tape monitor, scratch filter, rumble filter, phase reversal switch, loudness-volume switch, input selector, stereo selector, bass and treble controls, stereo balance, loudness control. Phase reverse switch permits use of

vertical transcription recordings. Third-channel output permits use of central channel. Input sensitivity 1.5 mv.—**H. H. Scott Inc.**, 111 Powdermill Rd., Maynard, Mass.

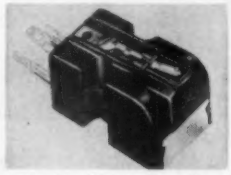
L-C TUNERS. Line of variable-tuned circuits combines variable inductance and capacitor in stable glass cylinder. Inductor winding acts as capacitor plates. Movement of piston in cylinder changes inductance and capacitance. *L-C J1A* (shown) has self-resonating frequency range

of 450–1,000 mc; loaded tuners resonate from 80 to 300 mc, according to load.—**JFD Electronics Corp.**, 6101 16 Ave., Brooklyn 4, N. Y.

PHONO NEEDLE LINE, *Full-Fidelity.* Covers all *Philco* and competitive models. Includes osmium, jewel- and diamond-tipped needles, each packed in newly designed plastic case. Compact jewel type merchandiser contains fastest-selling needles and cartridges. 24-page catalog for visual identification of all needle types and part-number comparison with manu-

facturers.—**Philco Corp.**, Accessory Div., C & Westmoreland Sts., Philadelphia 34, Pa.

STEREO CARTRIDGE, *CD model SC-1.* Dual ceramic unit



has single diamond stylus for all speeds and types of monaural and stereo discs. Frequency response 20–20,000 cycles. —**CBS-Hytron**, Danvers, Mass.

STEREO CARTRIDGE. Four-terminal turnover type. Similar

in size to monaural *TX-88 Superfluid. Duo-Clip* stylus assembly.—**Ronette Acoustical Corp.**, 190 Earle Ave., Lynbrook, N. Y.

CERAMIC MICROPHONE, *model CM-10.* Covers 50–13,000 cycles flat within ±3 db. Budget-priced unit has sensitivity of 57 db below 1 volt per microbar.

Omnidirectional, high impedance. With 7-foot shielded cable.—**Sonotone Corp.**, Elmsford, N. Y.

MINIATURE MIKE, *D801.* Dynamic type, designed for concealed use. Response 250–6,000 cycles, output level —52 db

(—46 db at voice frequencies). 1 5/32 (diameter) x 63/64 inch.—**American Microphone Manufacturing Co.**, 412 S. Wyman St., Rockford, Ill.

TRANSISTOR TESTER, *model 150.* Self-contained mercury-cell power supply. Tests all transistors and diodes, power transistors at high currents. Measures junction transmitter beta, accuracy within 5%. Built-in ac generator contains 1-kc transistor oscillator with buffer amplifier. Two beta scales read 0–50 and 0–250. Leakage current read directly on meter scale, 0–2,

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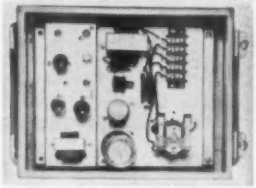
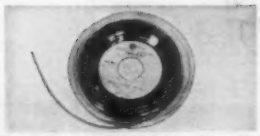
RADIO CONTROL SYSTEMS for commercial, industrial and residential use. Transmitter, receiver, antennas and hardware. Range from a few feet to more



than mile. Available for 117-volt ac, 6- or 12-volt dc operation. Multiple-channel units available with up to 12 non-interfering channels.—**Perma-Power Co.**, 3100 N. Elston Ave., Chicago, Ill.

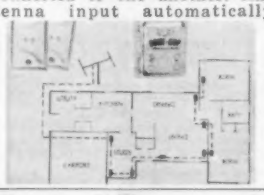
TEFLON TUBING. For laboratory and servicing applications. Will not melt when used near solder joints, remaining stable at temperatures from −450° to 500° F. 8 sizes, .022 to 0.106 inch ID in 5- or 10- and 100-foot spools. 3 colors.—**Walsco Electronics Manufacturing Co.**, 100 W. Green St., Rockford, Ill.



POWER-SAW KIT, *model 505K.* Includes "8 saws in 1" in kit form. Metal carrying case,

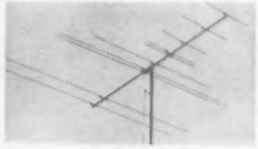
circle cutter, ripsaw attachment, 5 assorted blades. 1.8-amp motor developing 2,650 strokes per minute under load.—**Wen Products Inc.**, 5806 Northwest Highway, Chicago 31, Ill.

TV SWITCH RECEPTACLE, *Switchmatic.* Wall receptacles installed in desired locations in home. Antenna lead is connected to one and balance of receptacles connected to one another. Antenna input automatically



switched to receptacle in which TV set is plugged; unused lead wires are switched out. Two circuits can be operated from single antenna by adding *Humi-Kup* Switchmatic Interlock Coupler at antenna mast.—**R-Columbia Products Co. Inc.**, Highwood, Ill.

TV ANTENNA, *Clear-View CV-1* (1-bay) and *CV-2* (2-bay).



Designed for vhf fringe areas. Compact high-gain unit. All elements snap into position. Aluminum and aluminized riveted construction.—**Kay-Townes Antenna Co.**, Box 593, Rome, Ga.

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FM ANTENNAS. *Model FM-2K* in-line type (shown); *FM-1K,* turnstile type; *FM-6,* 6-element broadband Yagi for equal high gain over entire FM

band. *FM-1K* and *FM-2K* with complete installation kit.—**Trio Mfg. Co.**, Griggsville, Ill.

TAB MOUNT CONTROLS, *series B47.* Replacement line in-

cludes 25 resistance values meeting most electrical requirements. Each has 1-inch knurled and slotted phenolic shaft.—**Clarostat Manufacturing Co. Inc.**, Dover, N. H. END

All specifications on these pages are from manufacturers' data.

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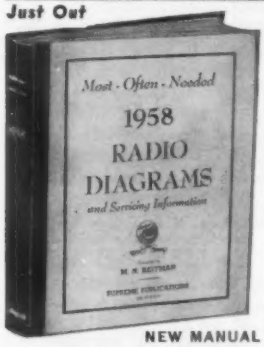

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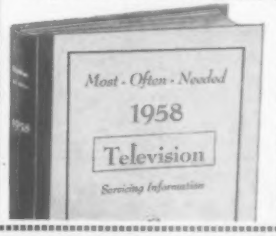

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☐ **12 POLY BOXES.** Clear plastic, hinged, w/snap locks. Asstd. sizes. Wt. 1 lb. **88c**

☐ **4 OUTPUT TRANSFORMERS.** 50L6, etc. Wt. 3 lbs. Reg. $8. **88c**

☐ **30 DISC CONDENSERS.** Wafer-thin. To .01 mf. Reg. $5. **88c**

☐ **"SUN" BATTERY,** similar to famed B2M. 1" long. Reg. $2.50. **88c**

☐ **35 PRECISION RESISTORS.** 1%, ½ & 1 W. Carboloy & WW. 100 ohms to 1 meg. Reg. $17. **98c**

☐ **15 ROTARY SWITCHES,** asstd. gangs. Wt. 3 lbs. Reg. $12. **88c**

☐ **60 HI-Q CARBON RESISTORS.** IRC. Ohmite, 1%, too! ½, 1 W, 10 ohms to 10 megs. Wt. 2 lbs. Reg. $13. **88c**

☐ **60 COILS, CHOKES.** IF, RF, Ant. Slug-tuned, too. Wt. 3 lbs. Reg. $15. **88c**

☐ **300-FT. HOOKUP WIRE.** Tinned, asstd. colors, sizes. Wt. 2 lbs. Reg. $5. **88c**

☐ **15 VOLUME CONTROLS,** incl. duals. To 1 meg; some w/switch. Wt. 2 lbs. Reg. $12. **88c**

☐ **1500 PCS. HARDWARE** Nuts, screws, washers, etc. Wt. 2 lbs. Reg. $8. **88c**

☐ **60 PLUGS, RECEPTACLES.** Audio, power, spkr., etc. Wt. 2 lbs. **88c**

☐ **40 HI-Q CONDENSERS.** Finest porcelain, NPO's too! Wt. 1 lb. Reg. $6. **88c**

☐ **8 GERMANIUM DIODES** w/long leads. Glass sealed. Reg. $5. **88c**

☐ **6 FERRI-LOOPSTICK CORES,** to 7". flat incl. Wt. 2 lbs. **88c**

☐ **15 INSTRUMENT KNOBS.** Raytheon. Bakelite, w/brass insert & set screws. Skirted incl. Wt. 2 lbs. Reg. $12. **88c**

☐ **35 TUBE SOCKETS,** 4 to 9-pin; ceramic, mica, shield-based, too. Wt. 2 lbs. Reg. $9. **88c**

☐ **20 PRINTED CIRCUITS.** Built-in R/C circuits, incl. integrals. Wt. 1 lb. Reg. $7. **88c**

☐ **125 CARBON RESISTORS.** ½ to 2 W; 15 ohms to 1 meg. Insulated types incl. Wt. 2 lbs. **88c**

☐ **SYLVANIA TV MIRROR.** 10x12" stainless steel. Many uses! Wt. 2 lbs. Reg. $4. **88c**

☐ **10 PANEL SWITCHES.** 115 VAC; SPST. SPDT, etc. Wt. 1 lb. **88c**

☐ **POSTAGE-STAMP MIKE.** Crystal, 100 to 8,000 cps. Wt. 1 lb. Reg. $7. **88c**

☐ **60 TERMINAL STRIPS,** solder-lug & binding; to 20 terms. Wt. 2 lbs. **88c**

☐ **6 TRANSISTOR SOCKETS.** Mica-filled; for sub-mini tubes, too. **88c**

☐ **30 MOLDED CONDENSERS.** Black Beauties, etc. Finest made! Wt. 2 lbs. **88c**

☐ **30 POWER RESISTORS.** WW. 5 to 50 W; to 10,000 ohms. Vitreous, too. Wt. 3 lbs. Reg. $15. **88c**

MORE OF LEKTRON'S FAMOUS

DOLLAR BUYS!

☐ **WORLD'S SMALLEST RADIO.** 2x1x1". Kit incl. loopstick, jacks, diode, etc. w/instructions. Reg. $3. Wt. 1 lb. **$1**

☐ **0-60 MINUTE TIMER.** Includes dial & knob. Sound alarm. Wt. 2 lbs. Reg. $5. **$1**

☐ **2 "MICRO" VARIABLES.** 10 to 365 mf, 1½" sq., w/shaft. Wt. 1 lb. **$1**

☐ **10,000 ohm SENSITIVE RELAY.** Sigma, 1" sq., SPST, w/neon bulb, etc. Wt. 2 lbs. Reg. $9. **$1**

☐ **9-PC. NUTDRIVER SET.** $3 value. Plastic handle, 3/16, 7/32, ¼, 5/16, 11/32, 3/8, 7/16" steel socket wrenches in plastic case. Wt. 1 lb. **$1**

☐ **3 VARI-LOOPSTICKS.** Adj. 540-1500 kcs. Transistor radios, etc. Wt. 1 lb. **$1**

☐ **2 PNP TRANSISTORS.** Pop. make, for hundreds of projects. $5 value. **$1**

☐ **2 TRANSISTOR IF's.** Double tuned. Only ½" square. **$1**

☐ **2 115 VAC MOTORS.** 1700 RPM. Reg. $8. Wt. 4 lbs. **$1**

HI-FI 12" SPEAKER

☐ Well-known U.S. maker. 40-12,000 cycles. 3-4 ohm v.c. Heavy PM Alnico magnet. Wt. 5 lbs. **$3.99**

POCKET MULTI-TESTER

☐ 3½ x 2 x 1½" bakelite case. 100 ohms/volt. Zero adj. 0/15/150/1000 AC-DC V; 0-150 ma; 0-100,000 ohms. W/test leads & battery. In orig. pack. $13 value. **$6.99**

NEW! AIR-POWERED TRANSISTOR RADIO KIT

☐ As described in "Transistor Topics" (July Popular Electronics). Developed by Telepower. Pocket size. Literally takes "power out of the air" from radiated energy of local radio & TV stations. NO BATTERIES NEEDED! Includes all parts, instructions, phone. **$6.50**

3-TUBE AC-DC AMP.

☐ Reg. $5. Fully wired, ready for use. Sep. vol., tone controls. Lowest price ever! **$2.99**

TUBES $1.91 EXTRA

HOW TO ORDER Check items wanted. Return entire ad w/check or M.O. including sufficient postage; excess returned. C.O.D. orders, 25% down; rated, net 30 days. Print name, address WITH POSTAL ZONE NO., amount money enclosed, in margin. (Canada postage, 48c 1st lb., 28c ea. addl. lb.) EXPORT ORDERS INVITED.

LEKTRON 131 Everett Ave. CHELSEA 50, MASS.

Castle Television Tuner Service

FOR THE EXACT TV TUNER REPLACEMENT USE A CASTLE REBUILT UNIT

EVERY REBUILT TUNER CARRIES FULL 90 DAYS WARRANTY

Aligned to Original Standards Under Laboratory Conditions

SAME DAY SERVICE
Exchange Tuner shipped same day defective unit received

(Any Tuner, for which a rebuilt unit is out of stock, overhauled & returned within 48 hours.)

$9.95 Dealer Net EACH TUNER
Including All Worn Parts (except tubes, where needed)
Combination UHF/VHF units, $19.90

Just forward defective Tuner prepaid. Complete with good tubes and all damaged parts; quote make and model.

1723 W. LUNT AVE., CHICAGO 26, ILL. **U.S.A.** AMbassador 2-7505

152 MAIN ST., TORONTO 13, ONT., **CANADA** OXford 4-5637

Suppliers of rebuilt TV Tuners to leading manufacturers, technicians & service dealers, coast to coast.

New Tubes & Semiconductors

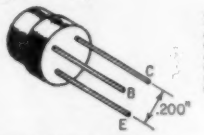
THIS month's releases range from high-frequency alloy-junction transistors to diffused silicon rectifiers, and include two tubes, one for TV sets and the other for auto radios.

2N417

A p-n-p alloy-junction transistor designed and tested for high-frequency amplifier applications up to 15 mc.

Maximum ratings of the Tung-Sol 2N417 are:

V_{CB}	30
V_{EB}	20
V_{CE}	10
I_C (ma)	200
I_C (peak ma)	400



2N417
2N438
2N439
2N440

2N438, 2N439, 2N440

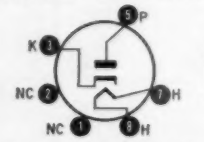
A group of n-p-n alloy-junction germanium transistors capable of very fast response under transient pulse operation. Their design is ideal for switching, flip-flop and if amplifier circuits. Each type has a different range of high-frequency alpha cutoff. In the 2N438 alpha-cutoff point ranges between 2.5 and 5 mc; in the 2N439 between 5 and 10 mc and in the 2N440 beyond 10 mc.

Maximum ratings of these CBS-Hytron units are:

P_{CB}	30
V_{EB}	25
V_{total} (mw) (derate 2 mw per °C increase in ambient temp)	100

6DA4, 12D4, 17D4

These indirectly heated half-wave rectifiers are intended for use as damping diodes in direct-drive sweep circuits for television receivers. Outside of their heater ratings, all three tubes are identical. The 6DA4 has a 6.3-volt 1.2-amp, the 12D4 a 12.6-volt 600-ma and the 17D4 a 16.8-volt 450-ma heater. The 12- and 17-volt versions are intended for series-string use and feature controlled warmup.



6DA4
12D4
17D4

Do not confuse the 12D4 and 17D4 with the gas triode 6D4. They are not 12- and 17-volt versions of that tube.

Pins 1, 2, 4 and 6 should not be used as tie points.

Superior's New Streamlined Model **TD-55**

TUBE TESTER

FOR

- **The Experimenter or Part-time Serviceman, who has delayed purchasing a higher priced Tube Tester.**
- **The Professional Serviceman, who needs an extra Tube Tester for outside calls.**
- **The Busy TV Service Organization, which needs extra Tube Testers for its field men.**

Speedy, yet efficient operation is accomplished by: 1. Simplification of all switching and controls. 2. Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 58, etc.) and providing sockets and circuits for efficiently testing the new Noval and Sub-Minar types.

CHECKS FOR SHORTS AND LEAKAGES BETWEEN ALL ELEMENTS—Model TD-55 provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. **"FREE-POINT" ELEMENT SWITCHING SYSTEM**—Model TD-55 incorporates a newly designed element selector switch system which reduces the possibility of obsolescence to an absolute minimum. Any pin may be used as a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap." **ELEMENTAL SWITCHES ARE NUMBERED IN STRICT ACCORDANCE WITH R.M.A. SPECIFICATION**—The 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

Model TD-55 comes complete with operating instructions and charts. Housed in rugged steel cabinet. Use it on the bench—use it for field calls. A streamlined carrying case, included at no extra charge, accommodates the tester and book of instructions.

$26.95

Superior's New Model **TW-11**

STANDARD PROFESSIONAL

TUBE TESTER

- **Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types. etc.** • Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary. • The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
- **Free-moving built-in roll chart provides complete data for all tubes.** All tube listings printed in large easy-to-read type.
- **NOISE TEST:** Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

- **SEPARATE SCALE FOR LOW-CURRENT TUBES—Previously, on standard emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the standard scale. The extra scale used here greatly simplifies testing of low-current types.**

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$47.50

Superior's New Model **82**

RAPID TESTER

The Very Best Value In Multi-Socket Tube Testers!

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. We don't expect it to replace conventional testers but if you want to try this new type of tester, you can do no better than mail the coupon below. **Don't let the low price mislead you!** We claim Model 82 will outperform similar looking units which sell for much more—and as proof, we offer to ship it on our examine **before** you buy policy.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82 the noval is duplicated eight times) permits elimination of element switches thus reducing testing time and possibility of incorrect switch readings.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch—THAT'S ALL! Read quality on meter. Inter-element leakage, if any indicates automatically.

FEATURES:

- ★ **Dual Scale meter permits testing of low current tubes.**
- ★ **7 and 9 pin straighteners mounted on panel.**
- ★ **All sections of multi-element tubes tested simultaneously.**
- ★ **Use of 22 sockets in improved circuit permits testing over 600 tube types and prevents possible obsolescence.**
- ★ **Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.**
- ★ **Employs new type 4" air-damped meter resulting in accurate vibrationless readings.**

$36.50

SHIPPED ON APPROVAL

NO MONEY WITH ORDER — NO C.O.D.

We invite you to try before you buy any of the models described on this and the following page. If after a 10 day trial you are completely satisfied and decide to keep the Tester, you need send us only the down payment and agree to pay the balance due at the monthly indicated rate. (See other side for time-payment schedule details.)

NO INTEREST OR FINANCE CHARGES ADDED!

If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

SEE OTHER SIDE!

Cut out and mail TODAY! ▶

All prices net, F.O.B., N.Y.C.

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BUSINESS REPLY CARD
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MOSS ELECTRONIC DIST. CO., INC.
3849 TENTH AVENUE
NEW YORK 34, N. Y.

Superior's New Model 76

ALL-PURPOSE BRIDGE

IT'S A

✓ CONDENSER BRIDGE ✓ RESISTANCE BRIDGE
✓ SIGNAL TRACER ✓ TV ANTENNA TESTER

SPECIFICATIONS:

CAPACITY BRIDGE SECTION—4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts, and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

RESISTANCE BRIDGE SECTION—2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

SIGNAL TRACER SECTION—With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

TV ANTENNA TESTER SECTION—Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy. Only **$26.95**

Superior's New Model 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER!

AS A DC VOLTMETER—Will measure any voltage up to 1500 volts with negligible loading. Indispensable in receiver and Hi-Fi Amplifier servicing and a must for Black and White and color TV servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER—Will quickly and simply measure RMS value if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers, sync pulses and saw tooth voltages are easily read.

AS AN ELECTRONIC OHMMETER—Because of its wide coverage of measurement in the resistance range (from .2 ohms to 1,000 megohms) the Model 77 will be your most frequently used resistance meter. Leaky capacitors show up glaringly when tested with the Model 77.

SPECIFICATIONS

DC VOLTS—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance.

AC VOLTS (RMS) — 0 to 3/15/75/150/300/750/1500 volts.

AC VOLTS (Peak to Peak)—0 to 8/40/200/400/800/2000 volts.

ELECTRONIC OHMMETER — 0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.

DECIBELS— —10 db to +18 db, +10 db to +38 db, +30 db to +58 db. All based on 0 db=.006 watts (6 mw) into a 500 ohm line (1.73v).

ZERO CENTER METER—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe, test leads and carrying case. Operates on 110-120 volt 60 cycle. Only **$42.50**

Superior's New Model 79

SUPER-METER

WITH NEW 6" FULL-VIEW METER!

***A Combination* VOLT-OHM MILLIAMMETER • *Plus* CAPACITY, REACTANCE, INDUCTANCE AND DECIBEL MEASUREMENTS • *Also Tests* SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES.**

SPECIFICATIONS

- **D.C. VOLTS**—0 to 7.5/15/75/150/750/1,500.
- **A.C. VOLTS**—0 to 15/30/150/300/1,500/3,000.
- **D.C. CURRENT**—0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
- **RESISTANCE**—0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
- **CAPACITY**—.001 to 1 Mfd. 1 to 50 Mfd.
- **REACTANCE**—50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
- **INDUCTANCE**—.15 to 7 Henries, 7 to 7,000 Henries.
- **DECIBELS**— —6 to +18, +14 to +38, +34 to +58.
  The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.
- **All Electrolytic Condensers** from 1 MFD to 1000 MFD.
- **All Selenium Rectifiers.** • **All Germanium Diodes.**
- **All Silicon Rectifiers.** • **All Silicon Diodes.**

Model 79 comes complete with operating instructions and test leads. Use it on the bench—use it on calls. A streamlined carrying case included at no extra charge accommodates the tester, instruction book and test leads. Only **$38.50**

SHIPPED ON APPROVAL

NO MONEY WITH ORDER — NO C. O. D.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-493, 3849 Tenth Ave., New York 34, N. Y.

Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no finance or interest charges added. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

- ☐ Model TD-55 . . Total Price $26.95 $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ Model TW-11 . . Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 82 . . Total Price $36.50 $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 76 . . . . Total Price $26.95 $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ Model 77 . . . . Total Price $42.50 $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 79 . . . . Total Price $38.50 $8.50 within 10 days. Balance $6.00 monthly for 5 months.

Name .....

Address .....

City ..... Zone ..... State .....

All prices net, F.O.B., N.Y.C.

We invite you to try before you buy any of the models described on this and the preceding page. If after a 10 day trial you are completely satisfied and decide to keep the Tester, you need send us only the down payment and agree to pay the balance due at the monthly indicated rate.

NO INTEREST OR FINANCE CHARGES ADDED!

If not completely satisfied, you are privileged to return the Tester to us, cancelling any further obligation.

SEE OTHER SIDE!

◀ Cut out and mail TODAY!

Maximum ratings of these Sylvania tubes in damper service are:

V_P (piv)	4,400
P_P (watts)	5.5
I (peak steady state) (ma)	900
I_P (ma)	155

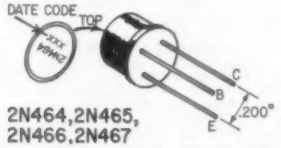
Abbreviations

A number of abbreviations used in reference to transistor characteristics are often confusing. To end any doubt as to what a particular symbol stands for this list has been assembled.

I_C, I_E, I_B—Dc currents to collector, emitter or base.
V_{CB}—Voltage, collector to base.
V_{EB}—Voltage, emitter to base.
V_{CE}—Voltage, collector to emitter.
V_{BE}—Voltage, base to emitter.
BV_{CBO}—Breakdown voltage, collector-to-base junction reverse-biased, emitter open-circuited (value of I_C should be specified).
V_{CEO}—Voltage, collector to emitter, at zero base current with the collector junction reverse-biased. Specify I_C.
BV_{CEO}—Breakdown voltage, collector to emitter, with base open-circuited.
V_{CCB}—Supply voltage, collector to base.
V_{CCE}—Supply voltage, collector to emitter.
V_{BBE}—Supply voltage, base to emitter.
I_{CO}—Collector current when collector junction is reverse-biased and emitter is dc open-circuited.
I_{EO}—Emitter current when emitter junction is reverse-biased and collector is dc open-circuited.
I_{CEO}—Collector current with collector junction reverse-biased and base open-circuited.
NF—Noise figure.
G_e—Common-emitter power gain.
G_b—Common-base power gain.
P_c—Collector power dissipation.
h_{ib}—Common-base input impedance, output ac short-circuited.

2N464, 2N465, 2N466, 2N467

Germanium p-n-p alloy-junction transistors designed for general purpose use in the audio-frequency range.



2N464,2N465, 2N466,2N467

Maximum ratings of these Motorola units are:

	2N464	-465	-466	-467
VCB	45	45	35	35
VCE	40	30	20	15
VEB	12	12	12	12
IC (ma)	100	100	100	100
P_C (mw) (derate 2.5 mw per °C above 25 °C)	150	150	150	150

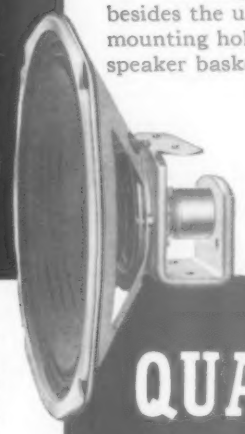
12EG6

A 7-pin miniature type pentagrid amplifier intended for use as an rf amplifier in hybrid auto receivers where tube and transistor voltages are ob-

NO SPEAKER INSTALLATION PROBLEMS with QUAM Adjust-a-Cone® SPEAKERS

QUAM speakers have transformer mounting brackets welded to the baskets.

There is a universal mounting bracket packed with every QUAM 3½", 4", 5", 5¼", 6½", 4" x 6" and 5" x 7" Adjust-a-Cone speaker, AT NO EXTRA COST. In addition there are four threaded mounting holes in the pot . . . besides the usual mounting holes in the speaker basket.



A good hi-fi speaker need not be expensive. Prove it to yourself by listening to QUAM extended range and coaxial speakers. They can't be beat for small budget hi-fi installations. Write for QUAM Hi-Fi Catalog No. 69.

QUAM HI-FI SPEAKERS for fine audio reproduction at low cost

ask for QUAM, the quality line for all your speaker needs

QUAM-NICHOLS COMPANY
236 EAST MARQUETTE ROAD • CHICAGO 37, ILLINOIS

SUPER POWERED SINGLE CHANNEL AMPLIFIER

Minimum 20 V—5 Watts on All Channels

This all new super powered unit has the highest output of any TV channel amplifier with sufficient power to cover large communities with ample signal voltage and deliver a strong signal thru many miles of cable. The unit was designed specifically for community television and is the only unit of its kind that does not produce power in fractions of a watt. For full rated output a high-powered commercial transmitting tube is used.

- C. C. S. Service
- 26 db min. gain
- 6-8 mcs. band width
- Channels 2-13 as specified
- Requires only 1 V input
- Co-axial input and output connectors for 75 OHM Line
- Linear class A operation
- Low Power Drain (1 Amp.)

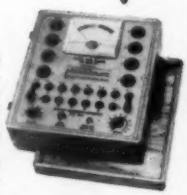
MODEL SPA
$350

Write for details today

SEG Electronics • 1778 Flatbush Ave., Brooklyn 10, New York

Demand the finest in Electronic Test Equipment – EMC, of course. You get the most quality per measurement dollar!

NEW! EMC Model 301 Speedi Tube Tester



Checks tubes in seconds. Checks shorts, leakages, and quality. Over 375 tubes, including 024, now listed. New listings available. Uses line voltage regulation. Checks and rejuvenates Picture Tubes with Model PTA (Picture Tube Adaptor), at only $4.50. **Model 301P** (illustrated), with 4½" meter & oak **Carrying case** **$47.50**
Kit **33.20**
Model 302C, (with 7½" meter) **62.90**
Kit **47.90**

NEW! EMC Model 108 Handi Tester

The only appliance and auto battery tester in its price class to use a D'Arsonval, instead of an iron vane type meter. Gives exclusive advantages of maximum accuracy and scale length, and minimum battery replacement cost . . . at no added charge. Complete with test leads and instruction manual.

Wired ..... **$15.95** **Kit** **12.95**

NEW! EMC Model 905-6A Battery Eliminator, Charger, and Vibrator Checker

A MUST for auto radio service. Features continuously variable voltage output — in either 6 or 12 volt operation. Checks all 6 or 12 volt vibrators.

Wired ..... **$67.90** **Kit** **44.90**

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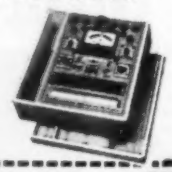

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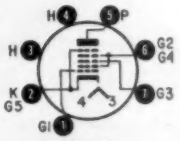

12EG6

tained from a 12-volt storage battery.

The design of this RCA tube permits using grids 1 and 3 as independent control electrodes. This provides for improved avc under large-signal conditions when both grids are biased by the avc voltage.

Maximum ratings in class-A1 amplifier use are:

V_P	16
V_{g2}, V_{g4}	16
V_{g3} (pos value)	0
(neg value)	−16
IK (ma)	20
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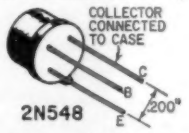
R_{g3} (megohms)	10

2N548

A medium-power n-p-n silicon transistor designed for switching and amplifying applications in output stages, servo-motor control, magnetic-



2N548

core switching, solenoid operation, dc-to-dc converters and medium-power oscillators. The collector is connected to the transistor's case.

Maximum ratings of the Transitron 2N548 are:

VCE	30
VCB	30
VEB	10
Ptotal	
(100°C case temp) (watts)	5
(200°C case temp) (mw)	500
(100°C amb temp) (mw)	600
(200°C amb temp) (mw)	50

1N1124,-1125,-1126,-1127,-1128

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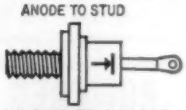
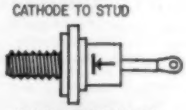


1N1124R TO 1N1128R

CATHODE TO STUD



1N1124 TO 1N1128

rent at 50°C and recurrent peaks of 10 amps. Peak inverse voltage ratings of these Texas Instruments rectifiers are: 1N1124, 200; 1N1125, 300; 1N1126, 400; 1N1127, 500 and 1N1128, 600 volts. Units with the anode connected to the stud are indicated by an R suffix after the type number. END

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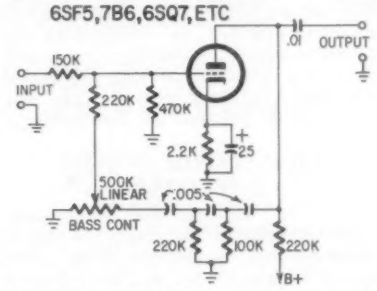
The tube can be any high-mu triode. The 6SF5 works admirably, but you could also use a 6SQ7, 7B6 or (with provision for a screen supply) a pentode like the 6SJ7. I feel that the triodes give better results.

The resistors in the grid circuit can be replaced with a volume control if desired. None of the parts is critical,



although feedback loop components should stay reasonably close to the values shown.

The one absolute requirement is a well-decoupled power supply, if power is taken from the main amplifier. Not only must this circuit be decoupled, but the other voltage amplifiers must be decoupled from each other or motorboating is a foregone conclusion. Needless to say, the power supply should also be hum-free.

It is usually preferable to build a separate supply using a small transformer and selenium rectifiers and use the unit as a preamp or between the preamp and main amplifier. In any event, this little unit will perform wonders for an inexpensive audio system.—*R. C. Sandison*

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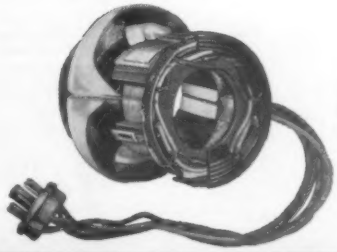

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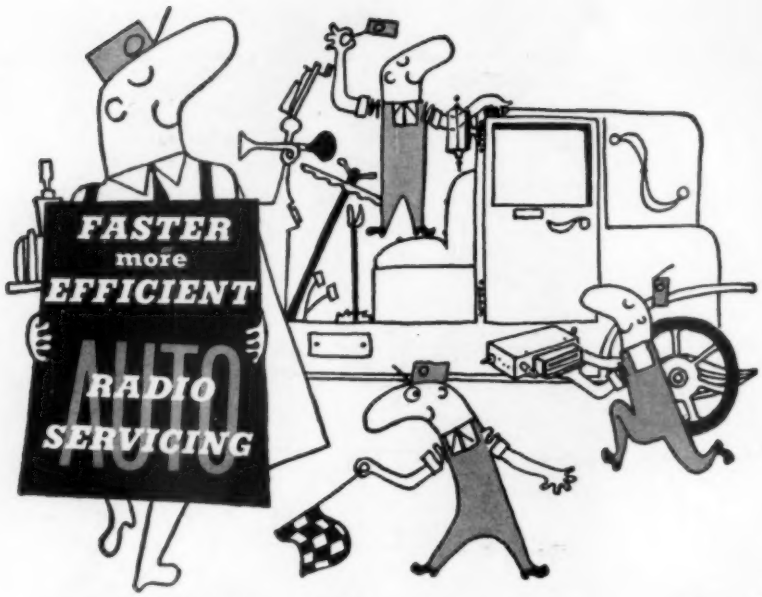

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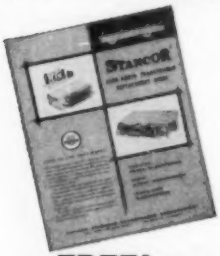

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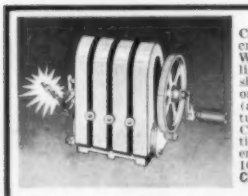

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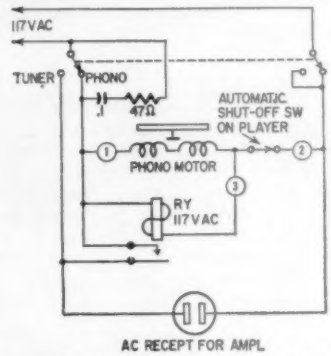
the unit works: With the dpdt switch in the PHONO position, the phono-motor switch turns on the motor and the relay pull-in couples the ac line to the amplifier. When the phono switch goes off, the relay opens and turns the amplifier off.

With the dpdt switch in the TUNER position, the ac line is fed directly to



the amplifier and the phono switch has no effect.

The 0.1-μf capacitor and 47-ohm resistor damp out the switch clicks. The autoswitch could be built into a small utility box or wired into the amplifier chassis. Points 1, 2 and 3 may be wired through a plug-and-socket connector so the player can be disconnected at will.—*T. Q. Sarmiento*

TRANSISTOR POWER AMPLIFIERS

Here are two circuits using audio power transistors that deliver 5 and 12 watts output, respectively. The 5-watt circuit uses a 2N301 or 2N301-A as a single-ended class-A amplifier (Fig. 1)

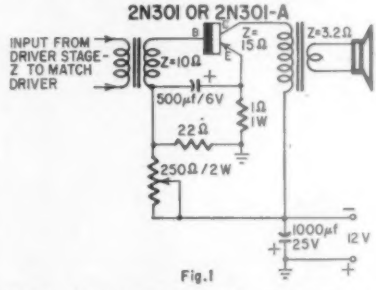


Fig.1

while the 12-watt circuit uses two of these transistors in class-B push-pull (Fig. 2).

To insure stable low-distortion op-

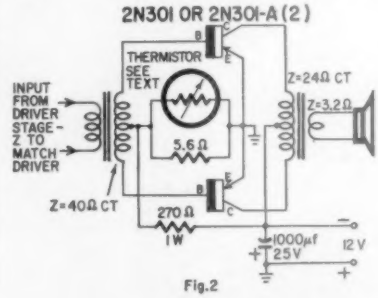


Fig.2

eration of the Fig. 1 circuit, degeneration in the emitter circuit is provided by the unbypassed 1-ohm resistor. In the push-pull circuit of Fig. 2 a different problem arises—thermal runaway. This can occur when transistors are operated near their maximum collector-voltage rating. The thermistor reduces base-to-emitter forward voltage in proportion to the transistor's operating temperature. Here a unit rated at 28.25 ohms at 0° C., 10 ohms at 25° C. and 4.06 ohms at 50° C. is used.

In both circuits it is important that the transistor mounting flange, which serves as the collector connection, be

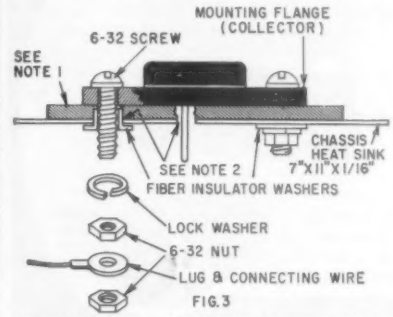


FIG. 3

NOTE 1: 0.002" MICA OR 1/8" THICK ALUMINUM INSULATOR, DRILLED, OR PUNCHED WITH BURRS REMOVED, AND THEN ANODIZED.

NOTE 2: REMOVE BURRS FROM CHASSIS HOLES.

fastened to a heat sink. Where this heat sink is the chassis and is connected to the positive terminal of the voltage supply, the transistors must be insulated from the chassis. This is done with either a ⅛-inch anodized aluminum insulator or a .002-inch mica insulator between the mounting flange and the chassis. See Fig. 3. These two methods provide insulation without impairing the chassis' heat-sink function. And don't forget to insulate the mounting bolt and nut from the chassis with fiber washers.

Both circuits appeared in an RCA transistor specification sheet giving tentative data on the 2N301 and 2N301-A power transistors. END

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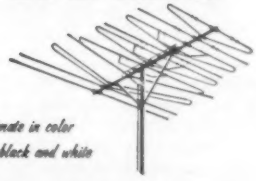

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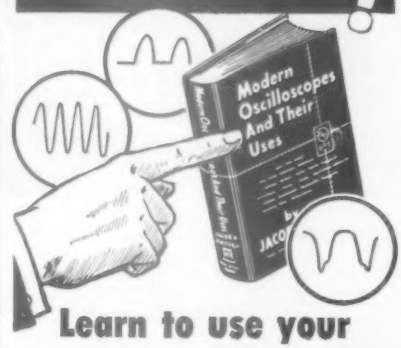

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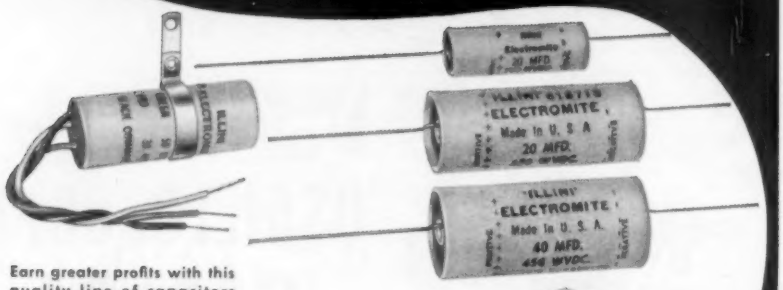

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Technotes

TAPE RECORDER HINTS

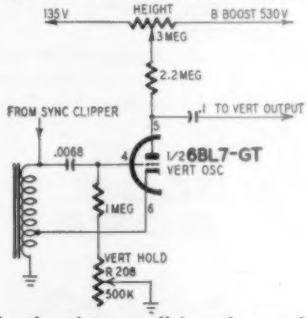
On Ampro model 758 recorders a common complaint is a whining noise in the takeup reel. To cure, dissasemble the reel and clean the felt clutch and glue it to the knurled side of the clutch disc. Grease the felt clutch lightly and reassemble.

Bell & Howell models 130, 130A and 300S have trouble with a whistling noise when volume is turned up. Replace the 10-megohm resistor at the first grid with an 8.2-megohm unit and the whistle will disappear.

Noise in the amplifier is a complaint with the Keystone K400. Sometimes it turns out to be tube trouble, but frequently this noise comes from the contacts in the PA phone jack. Either disassemble the jack and clean its contacts thoroughly or install a new one.—*Thomas L. Bartholomew*

G-E 21C111

After replacing the picture tube in this set, I happened to check the vertical hold control and found that it would



make the picture roll in only one direction. Checking further, I discovered that the control (R208), a 500,000-ohm pot, measured only 400,000 ohms. A quick replacement brought things back to normal.—*A. C. Hepperlen*

FRINGE SOUND PROBLEM

After a recent TV antenna installation in our fringe area, a servicing problem arose that may be of interest to other technicians in similar areas. A stacked broad-band high-gain vhf antenna had been installed and the receiver checked for performance on the three closest stations, channels 4, 6 and 10. The video signal came in nicely on all channels but the audio on channel 10 was badly distorted, sounding somewhat like a gassy output tube. However, the sound on channels 4 and 6 was clean, and we pulled the set to the shop.

Since the receiver used a strip type

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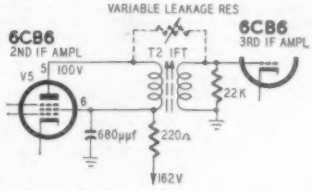
turret tuner and audio was distorted only on channel 10, we checked the channel-10 strip first. It was OK. Then the entire front end was aligned, but without success—distortion was just as bad as before.

After digging out the schematic, I began checking voltages and components in the sound if, detector, and first audio and audio output stages. A careful resistance check of the output stage disclosed a bad grid-return resistor—it was supposed to be 180,000 ohms but had gone up to 350,000.

The answer to the distortion problem suddenly became obvious. Channel 10 is much stronger in this area than channel 4 or 6 and the stronger signal was causing a large voltage drop across the bad grid resistor, resulting in too much bias voltage on the output tube—and causing distortion. — *Warren J. Smith*

BENDIX KS21E

The set was pulled to the shop for snow on all channels which increased as the receiver warmed up. The tuner was the obvious suspect, but no discrepancy in voltages could be found and tube substitution did not help. Following through the if strip, the only



flaw was at the plate and screen of the second if amplifier, a 6CB6. Voltages were lower than normal. The plate read only 100 instead of 120, but the B-plus line was high (162 instead of the rated 155 volts). Where was the voltage going?

A check of the second if transformer revealed a 10-megohm short between windings. Apparently as the set warmed up, the leakage became more pronounced. When the transformer was replaced, voltages returned to normal and the snow disappeared.—*James A. McRoberts*

END

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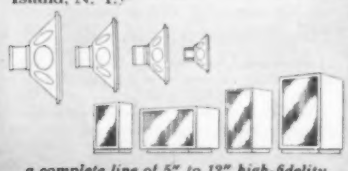

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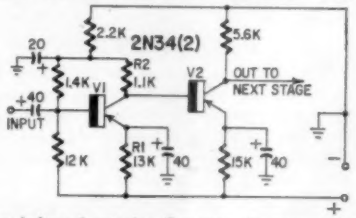
Patents

DIRECT-COUPLED TRANSISTOR AMPLIFIER

Patent No. 2,822,434

Robert J. Ehret (Assigned to Minneapolis Honeywell Regulator Co., Minneapolis, Minn.)

Direct coupling in electronic equipment is attractive from the standpoint of economy, compactness and simplicity. This transistor circuit may have as many as four or more stages yet be very stable. Temperature effects



are balanced out also. For example, assume that a temperature rise increases V1's collector current and produces a greater drop across R2. Then V2's base goes more *positive* to cancel the tendency for this transistor's collector current to rise also.

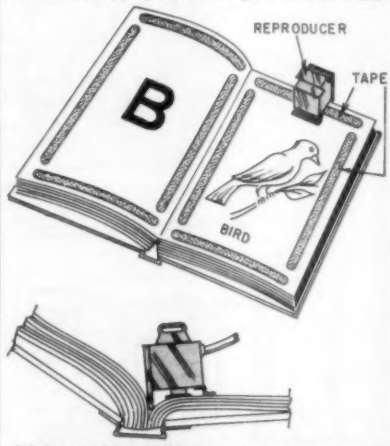
Each stage has less than unity voltage (dc) gain because each collector load is lower than the corresponding emitter resistor. However, there is considerable current (ac) gain, depending upon the transistor's beta. A single battery powers the entire amplifier.

LOOK–LISTEN BOOK

Patent No. 2,822,425

Walter R. Hicks, Manhasset, N. Y.

This book enables the reader to see and hear. Its pages are coated with magnetic tape along the edges. A reproducer is moved over the strips to hear the appropriate message. The idea is use-



ful for teaching children new sounds and words or for studying a foreign language.

The chief problem is the mechanical arrangement by which the reproducer may be held in place as it is moved. One method is shown in the diagram.

Amplifier and speaker may be placed in a separate unit, or a local oscillator can be used to broadcast to a nearby radio.

HI-FI OUTPUT TRANSFORMER

Patent No. 2,815,408

David Hafler, Philadelphia, Pa.

This inventor finds that high power with low

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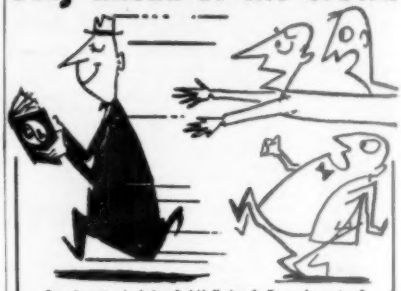

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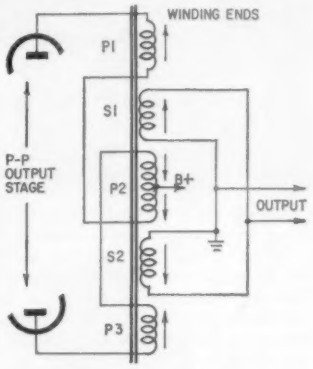
PATENTS *(Continued)*

distortion is possible when a transformer is wound as described here. A typical transformer shows only 1-db distortion over a range of 7 cycles to 70 kc at 50 watts output.

As shown in the diagram, the windings are sectionalized. Primaries and secondaries are wound alternately so that each serves as a shield for the others. Arrows show the rotational sense of each winding.

Each secondary is balanced with respect to the primary for true push-pull. For example, S1 is acted upon by P1 (immediately over it) and by



one half of P2 (immediately beneath it). Although P1, P2 are oppositely wound, they conduct current from different tubes so their effect is additive.

The only unbalance occurs for dc resistance and capacitance. The several coils are superimposed one over the other, with P3 nearest the core. Thus each coil must have a different resistance and dc capacitance. This disadvantage is compensated by the decrease in leakage, intercoil capacitance and shunt distributed capacitance.

END

CORRECTIONS

There is an error in the value of cathode capacitor C_x in Fig. 1 of "Final Touchup for Your Amplifier" in the May issue. The correct value of C_x is .005 μf. Make this change on the diagram and in the eleventh line of the second column of text on page 54.

Our thanks to John Addis, of Ormond Beach, Fla., for reporting the error.

In the article "How the Stereo Disc Works" in the July issue, the Electro-Voice 20 series stereo cartridge is erroneously referred to and discussed as a crystal type. The manufacturer has informed us that this cartridge uses barium-titantate ceramic generating elements.

There is an omission in the circuit of the R-C-L bridge, page 80 of the August issue, that makes it inoperative as a Hay inductance bridge. There should be a connection between the lower end of R11 and the bottom left contact of the M-H switch (S3).

It took a sharp-eyed telephone man, Edmund Sheffield, Jr., of Pacific Telephone & Telegraph, to spot the error.

In Figs. 1 and 3 of the article "Gating with Diodes" in the August issue, the diodes were inadvertently reversed. Our thanks to Richard Kolker of Huntington, N. Y., for reporting the error.

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1X2A	.68	6J6	.59	12BZ7	.99	4X500	38.00
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6AH6	.99	6SK7	.72	25W4	.77	810	10.00
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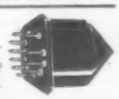

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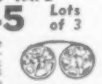

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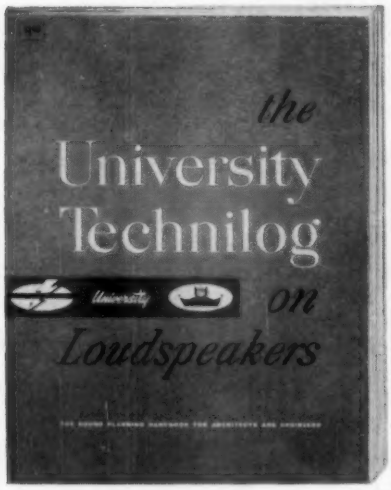

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The tape recording enthusiast who has no stand-mounted mike can easily mount his hand-held mike on a base removed from a discarded electric desk fan. I mounted mine as shown in the photo, by making a loop from TV ribbon line, punching a hole near either end, and fastening the loop to the fan base with a machine screw and washers. (You have to space the holes in the loop and determine its length for a snug fit by wrapping the lead around the contour of your individual mike.)

Once I had the lead fastened in place on the base, all I had to do was force fit my mike into the loop's opening. Using the base as a stand, I can quickly mount or dismount the mike and angle it up or down for good sound pickup.—*John A. Comstock*

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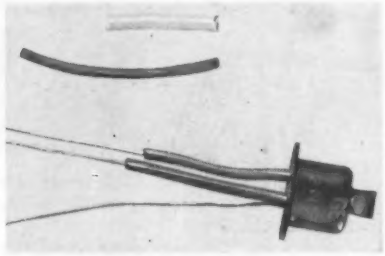
In miniature circuit construction the experimenter uses component leads to a greater extent than in conventional-size construction projects. Transistor leads usually are soldered directly to other components in the circuit.

Leads of miniature components and transistors are smaller than those on more conventional-size parts and, if the



builder uses standard spaghetti for insulation, the leads become hard to work with.

I've found the plastic insulation I strip off No. 22 hookup wire is ideal for insulating spaghetti in miniature circuit work. Now I save the insulation I strip off hookup wire for use as spaghetti in miniature circuits. This spaghetti is flexible and small enough to do credit to miniature circuits.—*Forrest H. Frantz, Jr.*

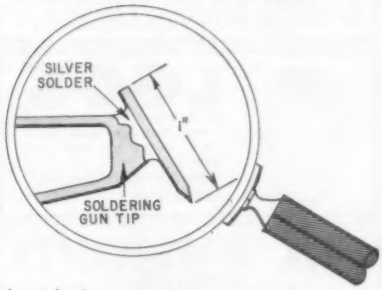
USE AN ATOMIZER

One of our most useful shop tools is an old-fashioned throat atomizer. We keep one filled with contact cleaner on the shelf and, whenever a set comes in with dirty controls or switch contacts, it's put to work.

It's especially helpful when we encounter an erratic RCA tuner. Rather than disconnect and dismantle the whole front end, we spray a mist of cleaner through the vent holes and have a like-new tuner in 10 seconds. Of course, this will also work on other sets using switch tuners.—*Frank Salerno*

SOLDERING TIP FOR PRINTED CIRCUITS

For fine, hard-to-reach work or the repair of printed circuits, use a soldering-gun tip modified as in the diagram.



A 1-inch extension made from the shank of an old tip is silver-soldered to a standard tip. When working where a fine tip is needed, just slip the modified tip into the iron.—*S. Clark*

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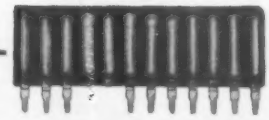

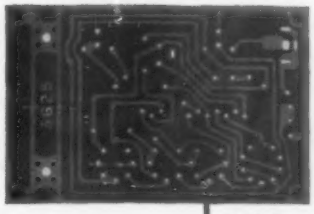

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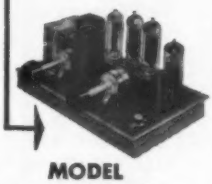

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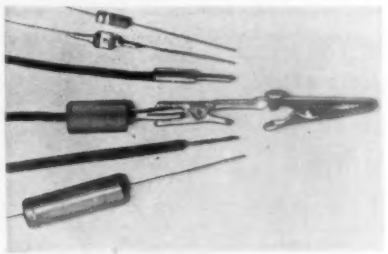
To protect a transistor from blows that are likely to injure it internally, I slip a rubber grommet over the transistor's case. The grommet makes a protective bumper that wards off damaging blows. Grommets are available that will fit almost every round or oval transistor.—*John A. Comstock*

CONNECTIONS WITH ALLIGATOR CLIPS

The versatile twin clip shown in the photo lets you make quick and easy connections to an alligator clip in experimental work. Such parts as wire leads, fixed capacitors, fixed resistors, variable resistors, germanium diodes, phone tips, banana plugs, etc. may be connected to the piggyback clip, and then the main clip may be used in the normal way.

To make this twin clip, simply force the lug end of a Mueller No. 30 clip into the sleeve of a Mueller 60 clip, and then mash the sleeve with a pair of pliers. A bit of solder helps make a solid joint.

If you want to use the larger 60 clips on both ends, simply squeeze one sleeve



to a smaller diameter and force it into the other sleeve. Then run a little solder over the joint.—*Art Trauffer*

INSULATING RF CHOKES

An rf choke with exposed metal ends can be insulated against accidental contact with a chassis ground or other components by spray-insulating its ends with anti-corona dope.

Do not spray the piewound sections any more than absolutely necessary, for too much dope may increase the choke's distributed capacitance, lowering its effectiveness in the circuit.—*J. C. Alexander*

END

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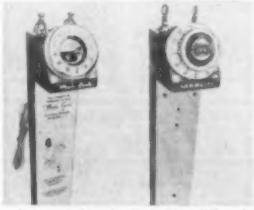
Business and People

Jensen Industries, Forest Park, Ill., is promoting its new line of phonograph cartridges with a display card which

will accommodate six of the most popular types in transparent plastic cases. A screw-holding screwdriver is offered the purchaser of each cartridge.

JFD Electronics Corp., Brooklyn, N. Y., was awarded a mechanical patent



and design patent for its Magic Genie and Merlin indoor TV antennas.

National Schools, Los Angeles, is exhibiting a full-scale model of the Explorer I, the United States' first satel-

lite. E. Witke (left), National Schools instructor, is shown pointing out the instrument package included in the exhibit.

Amperex Electronics Corp., Hicksville, N. Y., is importing and distributing Valvo tubes which are used extensively in German-made radios and hi-fi equipment. The replacement tubes will be

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sold through regular Amperex distributors.

Thorens Co., New Hyde Park, N. Y., importers of Swiss-made hi-fi products, announced the winner of its recent contest for the best description of an ideal hi-fi salesman. Prize is the choice of

any one Thorens hi-fi product every year for the next 10 years. In the photo, James Carroll (left), Harvey Radio, described as the ideal hi-fi salesman, receives a check of recognition from Paul W. Kind (right) of Thorens. Hannes Beckmann, the contest winner, looks on.

The EIA reported the sale of 14,894,230 transistors for the first five months of 1958 compared to 8,954,000 for the January–May period in 1957. The institute expanded its statistical service, effective July, with the collection of monthly factory-production figures on FM receivers. It estimates that there are now 11.8 million FM receivers in use in the US.

Reed Vail Bontecou joined CBS-Hytron, Danvers, Mass., as vice president—marketing, of the CBS Electron Tube and Semiconductor Div. He comes to CBS-Hytron from General Electric where he was manager of marketing for the Receiving Tube Dept.

Leslie M. Cassidy is now director of Daystrom, Inc., Murray Hill, N. J. He was formerly president and chairman of Johns-Manville where he has been serving as a director and consultant since last year.

Dr. Alfred K. Wright, vice president in charge of engineering for Tung-Sol Electric, Inc., Newark, N. J., was given additional responsibilities as vice president in charge of Operations and En-

gineering. **Paul Scharninghausen,** (right) general manager–electron-tube manufacturing, was advanced to vice president and general manager of the Radio and Television Tube Div.

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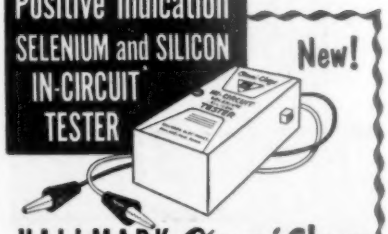

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- Detects inferior rectifiers weeks before they cause trouble in sets.
- Cuts down callbacks—helps rectifier sales.

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16GP4	19.75	20CP4B*	21.95	(6 mos. guar.)	
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Milwaukee, Wis., presented cash awards to the three winning rep organizations in its capacitor-kit sales contest. In the photo, left to right, Gerry Mills, Centralab distributor sales manager, presents checks to Ted Lowell, Gordon LeRoy and John McGuire (of LeRoy & McGuire), and Les Logan.

Arthur F. R. Cotton, British electronics engineer, joined Capitol Radio Engineering Institute, Washington, D. C., as director of European operations. He has set up overseas headquarters in London.

Electro-Voice, Inc., Buchanan, Mich., named William R. Lanphear, Seattle, as its sales representative of the year.

H. H. Scott Inc., Maynard, Mass., announced the winners of its 1957-58 sales awards at its annual sales meeting. Jack Fields Sales Co. rang in the best overall sales performance. Rod Butchart Co. showed the greatest gain in territorial sales volume, and F. W.

Moulthrop Co. notched the outstanding sales achievement award. Jack Fields and Jack Simon are shown receiving plaque from Herman Hosmer Scott.

John Q. Adams, vice president–sales, of CBS-Hytron, Danvers, Mass., retired after 15 years with the company and 36 years in the industry.

Harry J. Veitch, formerly with Oak Manufacturing Co., joined Phaostron Instrument and Electronic Co., South Pasadena, Calif., as vice president in charge of sales. END

Answers to the quiz on page 95

1. K	8. T	15. Q
2. G	9. A	16. D
3. R	10. H	17. S
4. N	11. E	18. O
5. I	12. M	19. F
6. P	13. B	20. L
7. C	14. J	

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The Mark II is the best buy in high power high fidelity kits

- ★ Ease of assembly due to uniquely simple circuitry and printed circuit construction with factory-mounted parts.
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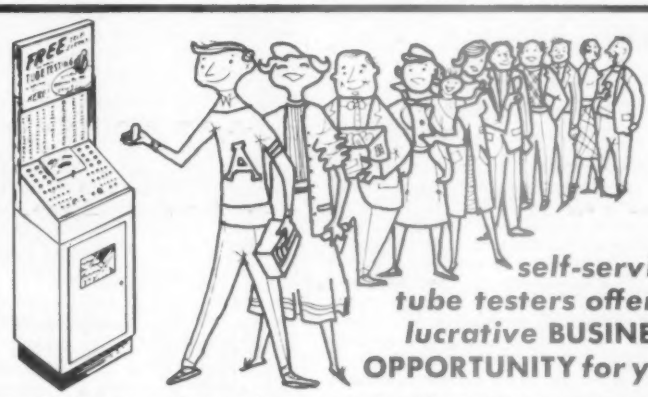

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Universally adjustable "U"-type rugged steel mounting . . . finished in high temperature baked modern beige enamel.

Power Rating	15 watts continuous
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Dispersion	120°
Dimensions	Bell opening 15", overall depth 12"

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technical Literature

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

COIL REPLACEMENT GUIDE for TV technicians, *No. 159*. This 72-page loose-leaf-punched book lists replacement coil numbers for virtually all TV chassis. Listed are picture and sound if transformers, adjustable ion traps, video peaking coils, antenna matching coils, linearity and width controls, horizontal oscillator and sync control coils.—**J. W. Miller Co.,** 5917 S. Main St., Los Angeles 3, Calif.

"DON'T DO IT YOURSELF," advises a pocket-sized folder, designed for distribution by TV technicians. Containing reprints of cartoon advertisements originally printed in *TV Guide*, the folder *TV Service Safety Hints* dramatizes the dangers and pitfalls of amateur doctoring of TV ailments.—**P. R. Mallory & Co. Inc.,** Distributor Div., 34 S. Gray St., Indianapolis 6, Inc. **$1 per 100.**

FOR THE TECHNICIAN there's a little of everything in the 1959 edition of the *G-C* catalog *(No. 158)*. The 80-page book includes, as usual, cements and chemicals, tools and service aids, speaker kits, plugs and jacks, test leads, switches, components and hardware—**General Cement Mfg. Co.,** 400 S. Wyman St., Rockford, Ill.

WIRE AND CABLE, from mike cables to appliance cords, comprise 20-page 2-color *Catalog No. 58*, which features *Parallead* lead-in the plus standard and custom-constructed wire and cable for virtually every electronic need.—**International Wire & Cable Co.,** 1665 N. Milwaukee Ave., Chicago, Ill.

SERVICING BOOKS using "comparison method" of troubleshooting are listed in 4-page circular.—**Supreme Publications,** 1760 Balsam Rd., Highland Park, Ill.

SMALL MOTORS of fractional horsepower, designed for phonographs, fans, tape recorders, advertising displays, antenna rotators, remote TV tuning and other uses are subject of loose-leaf catalog containing data sheets for each type of motor.—**General Industries Co.,** Elyria, Ohio.

JACKS AND PLUGS occupy most of the space in 12-page *Bulletin 558*, which also includes push-button switches,

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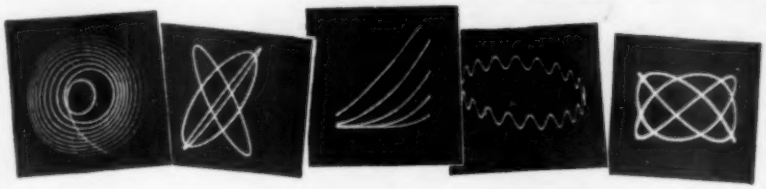

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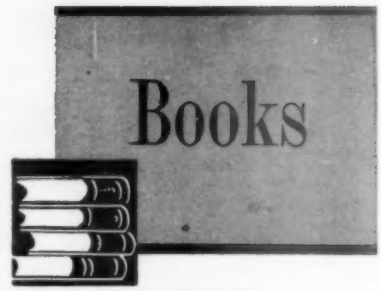

TRANSISTOR CIRCUITS, Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y. 6 x 9 inches, 53 pages, 35c.

This is the latest booklet for transistor hobbyists and experimenters. A glance through the 36 circuits shows a wide variety of useful instruments. There is a burglar alarm, metronome, high- and low-voltage supplies, blinker, logic circuit and many others. For each circuit, there is a schematic, parts list and details for construction and operation.

The first few pages tell how semiconductors amplify. The remainder of the booklet is strictly practical and easy to understand.—*IQ*

CARE AND REPAIR OF HI-FI, by Leonard Feldman. Cowan Publishing Corp., 300 W. 43 St., New York 30, N. Y. 5½ x 8½ inches, 156 pages, $2.50.

Directed at the experienced service technician, this book dwells on those points which he is less likely to have worked with in straight radio and TV servicing. He is alerted as to the possibility of and reasons for dc filament supplies in preamplifiers early in the book, for example. Other chapters deal with tone controls, loudness controls, equalization, cathode followers and phase inverters, as well as a number of chapters on such more familiar subjects as power amplifiers and power output stages (which are different, however, in hi-fi amplifiers!). Numerous illustrations and schematics.

AUDIO DESIGN, by H. A. Hartley. Gernsback Library, Inc., 154 W. 14 St., New York 11, N. Y. 5½ x 8½ inches, 224 pages. $2.90.

This author is well qualified in the hi-fi field. He has pioneered and specialized for over 30 years in quality reproduction, and claims to have originated the term "hi fi" in 1927. Here Mr. Hartley offers an excellent and most readable guide book for hi-fi enthusiasts and music lovers. Especially helpful are the many tables and diagrams which simplify design work and eliminate the need for mathematics.

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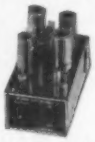

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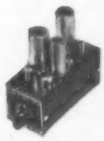

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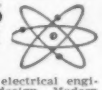

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In the final chapter Mr. Hartley tells his personal ideas on hi fi and distinguishes between the needs of the "audiophile" and the "music lover." It is my personal opinion that both groups can greatly benefit from this informative book.—*IQ*

THE ENCYCLOPAEDIA OF RADIO AND TELEVISION. J. H. Reyner, Technical Consultant. Philosophical Library, Inc., 15 E. 40 St., New York 16, N.Y. Second edition. 5½ x 9 inches, 736 pages. $12.

From "A (Abbreviation for ampere)" to "Zoom lens," this standard British work contains more than 3,000 entries with many diagrams, treating the main aspects of modern radio and television engineering. The book is the work of 13 English authorities and is essentially similar to the 1950 edition except for a 100-entry appendix on recent developments, dealing with such subjects as FM and color television.—*DL*

LOW POWER TELECASTING, by Harold E. Ennes. Howard W. Sams & Co., 2201 E. 46th St., Indianapolis 5, Ind. 6 x 9 inches, 106 pages. $2.95.

Written for station owners and operating personnel, but also of general interest to the technically minded, this book details the new phenomenon of small-town low-powered installations, with chapters on antennas and propagation, transmitters, the Vidicon camera and associated equipment and general station construction.

ELECTRONIC PUZZLES AND GAMES, by Matthew Mandl. Gernsback Library, Inc. 154 W. 14th St., New York 11, N.Y. 5½ x 8½ inches, 127 pages. $1.95.

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TV DISTRIBUTION SYSTEMS AND ANTENNA TECHNIQUES, by Jack Beever. Howard W. Sams & Co., Inc., Indianapolis 5, Ind. 5½ x 8½ inches, 167 pages. $2.95.

Beginning with a discussion of antenna fundamentals, installation, phasing and interference problems, the book goes on to passive and then to amplified distribution systems, uhf conversion and television distribution amplifiers and long-run systems. The book closes with a chapter on how to sell distribution systems. END

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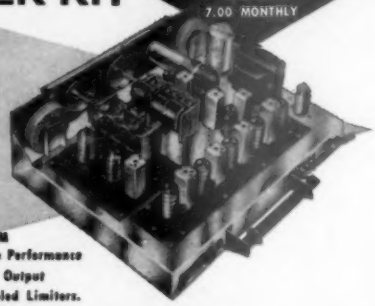

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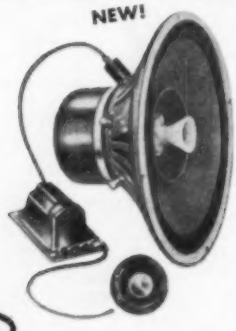

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Includes a 15" three-way speaker such as: E-V EMPIRE* (with 15TRXB), Net $178

EMPIRE* 15TRXB: Similar to 12TRXB, but with added bass efficiency from large cone, and delivering lower bass response.

E-V systems which can be expanded with E-V Building Blocks whenever your budget permits.

NOTE: all E-V enclosures also available in limed oak or walnut finishes

STEP ONE

You need the totally compatible E-V STEREO CARTRIDGE

- the first stereo cartridge
- the only field tested stereo cartridge

Thousands already in use prove it

- Plays ALL RECORDS BETTER. Unexcelled for stereo; superior even to your present cartridge for monaural
- Highest vertical and horizontal compliance. For superior tracking, longest record wear
- Best channel separation over 20 db between channels
- Flattest response. Flat beyond audibility to RIAA curve
- Hum and rumble far below any magnetic cartridge
- Two ceramic elements deliver precise RIAA curve with no hum!
- Exclusive E-V Built-in Vertical Rumble Suppressor allows record changer use for stereo
- .7-mil replaceable (diamond or sapphire) stylus is the ideal size . . . gives you better reproduction, longer record wear

Then choose a second amplifier and preamplifier. If this is your initial high fidelity system, start with any stereophonic dual amplifier-preamplifier. Play monaurally until you add a second speaker for stereo.

The E-V Totally Compatible Stereo Cartridge is the industry's standard. Choose the model to fit your needs:

MODEL 21D—Stereo with .7-mil Diamond Stylus, Net $19.50

MODEL 26DST—Dual Stylus Turnover from .7-mil Diamond Stereo to 3-mil Sapphire Monaural, Net $22.50

or the E-V Velocity Stereo Cartridge

MODEL 21MD—Stereo with .7-mil Diamond Stylus, Net $19.50

MODEL 26MDST—Dual Stylus Turnover from .7-mil Diamond Stereo to 3-mil Sapphire Monaural, Net $22.50

STEP TWO

Add-on E-V BARONET*...

smallest folded-horn corner enclosure for best musical balance and response range; phenomenal bass range; extended two full octaves. Matches the Coronet and other comparable speaker systems. With SP8B, Net **$74.50**, or BARONET III with SP8B and T35B VHF driver, Net **$111.50**

OR

Add-on E-V ARISTOCRAT*...

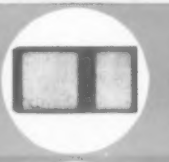
popular folded-horn corner enclosure . . . compact, economical . . . delivers most extended bass range for its size. With SP12B, Net **$107.00**; with 3-way 12TRXB, Net **$138**

OR

Add-on E-V MARQUIS*...

matching along-the-wall counterpart of the popular Aristocrat. Response down to 40 cps. With SP12B, Net **$98.00**; with 3-way 12TRXB, Net **$129**

OR



Add-on E-V REGAL III...

super-compact, specially designed system with tailored components to give enhanced range and purity of tone with least loss of efficiency. Does not require high powered amplifier, Net $147.50

OR

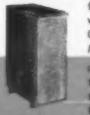
Add-on E-V EMPIRE*...

direct radiator Klipsch-licensed low-boy enclosure tailored for use along-the-wall or in corner. Smooth, extended bass response. With Electro-Voice 15TRXB 3-way speaker, Net $178

Systems shown are but a few of the multitude of E-V combinations found in every price class. Ask your dealer or write Electro-Voice for information on the industry's most complete line of high fidelity speakers and enclosures.

Add-on the new E-V CORONET*...

true, balanced high fidelity reproduction in extremely small economical space-saving



form: only 10 inches of wall space required. Complements Aristocrat, Marquis, Baronet or comparable speaker system. With SP8B 8-inch speaker, response down to 70 cps., Net **$65.00** or add-on CORONET IA with SP8B and T35B VHF driver, **$102.00**, or add-on REGAL IA, Net **$103**

Add-on STEREON IA

The all-new Electro-Voice speaker system that solves your space problem—saves you money. Where space doesn't permit you to add a second full-range speaker, a Stereon is the answer. It's compact, because the Stereon reproduces only those frequencies needed for stereo. Bass below 300 cps does not contribute to the stereo effect . . . so bass from both is handled by your present full-range speaker through the accessory XX3 Stereon Control Filter. (Finest E-V mid-bass, treble and high frequency components give smooth response from 300 to 19,000 cps.)

STEREON IA—for systems of normal efficiency, Net **$99.50**

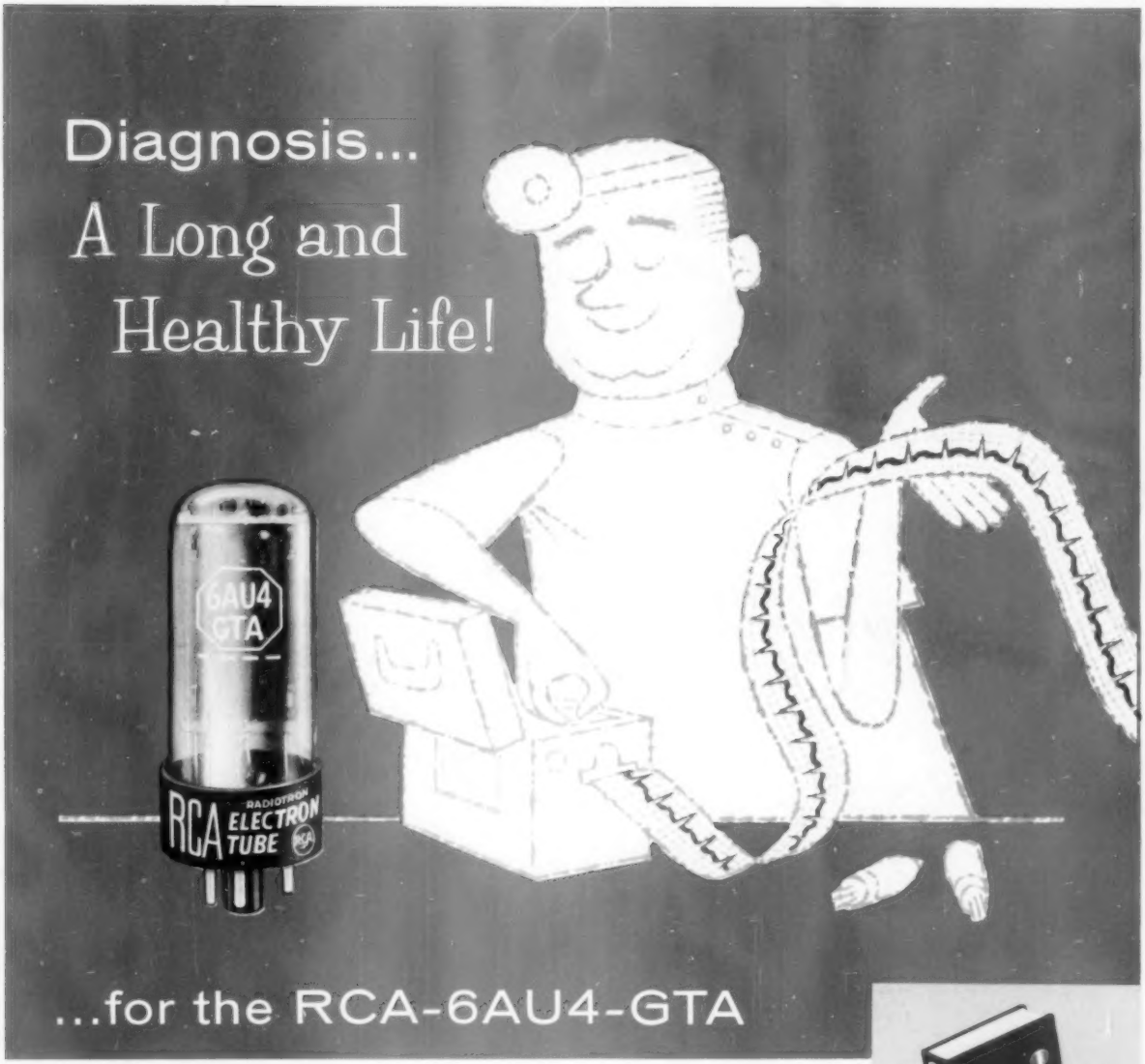
XX3 STEREON CONTROL FILTER, Net **$30**

Electro-Voice®

ELECTRO VOICE INC. BUCHANAN, MICHIGAN

Foremost in Electro Acoustics—Microphones, Phono Cartridges, High Fidelity Loudspeakers and Enclosures, Public Address Speakers, Marine Instruments, EVI Professional Electronic Instruments and Military Material

Diagnosis... A Long and Healthy Life!



...for the RCA-6AU4-GTA

A "diagnosis" of the RCA-6AU4-GTA shows why it gives top performance for extended hours of operation.

Tube life is increased through improved heat dissipation, achieved with an increased bulb area, new plate shape, and the use of special "clad" plate material. *Early-hour failure is minimized* by elaborate precautions against internal contamination during production. *Borderline tubes are eliminated* through emission tests at extremely low heater voltage, and by aging and life tests at increased plate dissipation. The result is a tube with an unusual ability to resist plate-to-cathode arcing and internal breakdowns.

RCA-6AU4-GTA—*preferred* for TV damper circuits by original equipment designers—is a tube you can rely upon for replacement purposes. Do the same as *all* experienced TV technicians do, always ask your RCA Tube Distributor for RCA tubes!

Speed Up and Simplify Your Color-TV Servicing With RCA's New PICT-O-GUIDE

It's chock-full-of practical information and illustrations—just what you need for profitable color-TV servicing. Available through your RCA Tube Distributor or send check or money order for $4.50 payable to Radio Corporation of America, to RCA Commercial Engineering, 415 South 5th St., Harrison, New Jersey.

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Electron Tube Division — **Harrison, N. J.**